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POWER

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Index to Advertisers, 39.

RHOADS
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We all like belting that gives little trouble and big output. Tannate Belting gives you the output and saves trouble.

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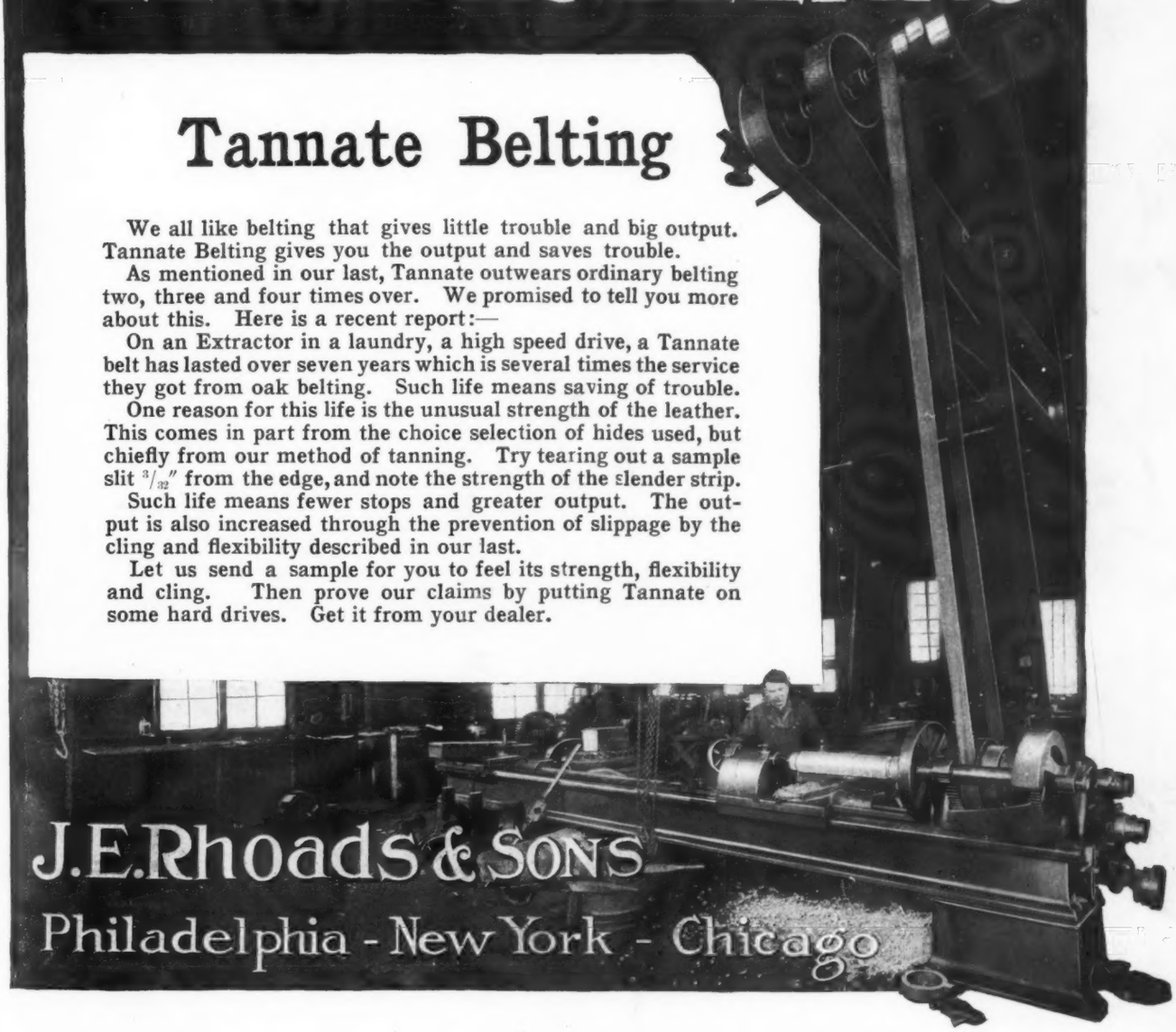

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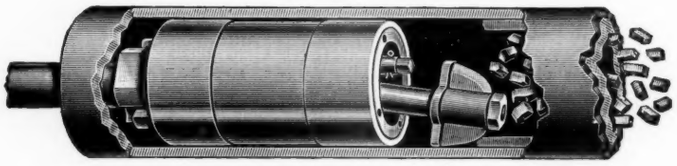
THERE are probably more devices and schemes for removing or preventing scale than for any other power plant purpose—yet boiler scale is still with us.



The Dean Removing Scale from the Tube of a Water Tube Boiler.

And coal is still wasted by the lining or covering of scale on boiler tubes—which is about as sure a non-conductor of heat as you can find.

This because the "scale preventers" don't prevent and "removers" don't remove.

That is, they don't do the job thoroughly, if at all.

And it's for just this reason that the **Dean Boiler Tube Cleaner** appeals to practical engineers.

The Dean operates on a principle that compels thoroughness.

It will remove pound after pound of scale from boilers that have been "cleaned" by other processes or methods.

It enables the engineer to show tangible fuel savings and helps him to get recognition from the "old man" quicker than anything else.

And any engineer can prove this to his own satisfaction at no cost whatever—we know the Dean, we know the scale proposition, we take all the risk.

We know it will pay any engineer to find the scale remover that really, thoroughly removes all the scale—

Therefore we know it will pay us to send you a Dean Cleaner with no strings attached to it.

The thing for every progressive engineer to do right now is to read and take up—

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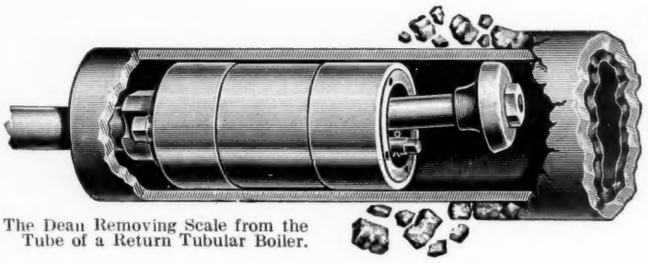

The Dean Removing Scale from the Tube of a Return Tubular Boiler.

Try the Dean in one boiler and if you don't like it, send it back at our expense.

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Its width..... Combined horsepower of engines.....
Tap size of cup.....
FIRM.....
Per .....
City ..... State.....
Size cap required.....

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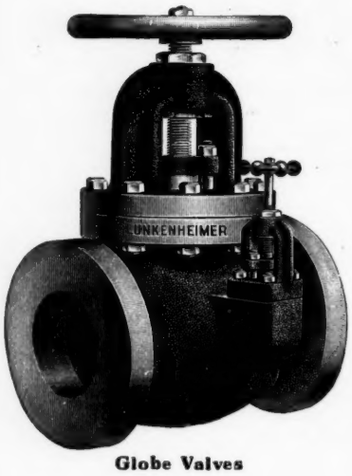
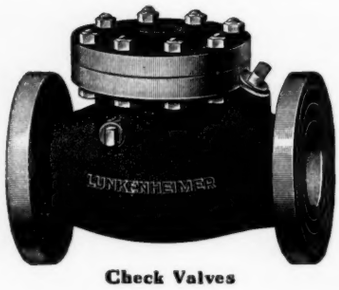
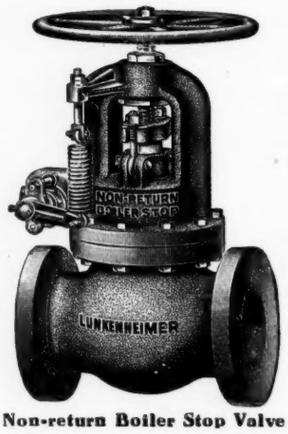


Globe Valves



Check Valves

Gate Valves



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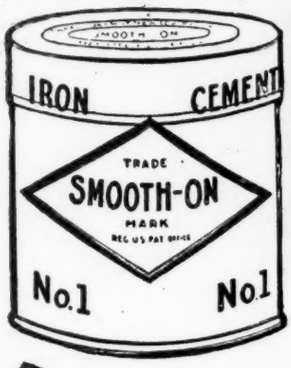

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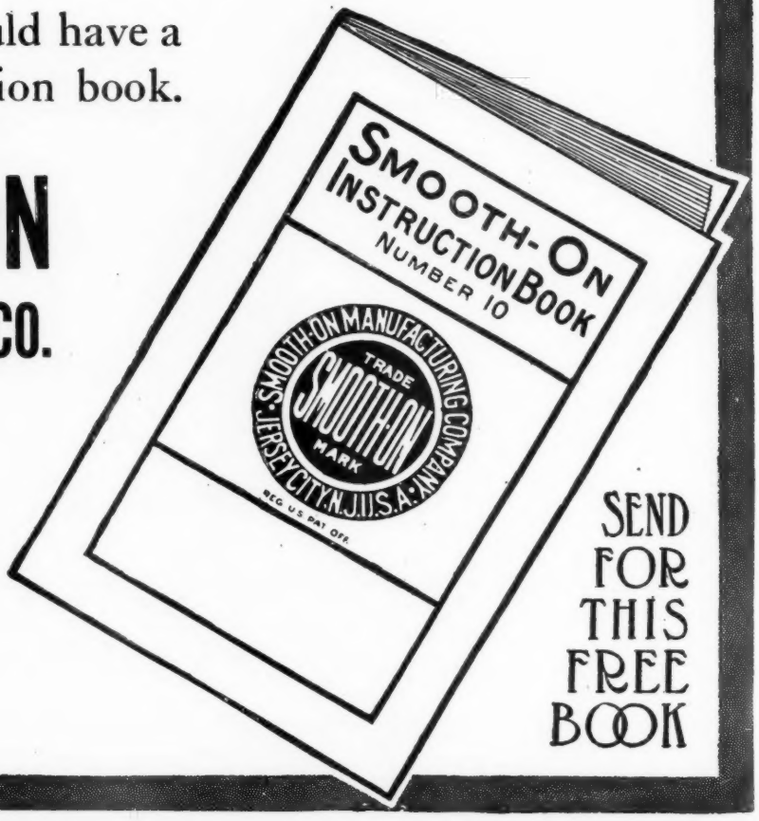

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POWER

Vol. 35 NEW YORK, APRIL 9, 1912 No. 15

Some interesting experiences have been published in POWER from time to time as to the use of sand in hot bearings, and there was a wide diversity of opinion as to its value when so used. Its efficacy seems to depend upon where and how it is used, and the difference of opinion is still wide and unsettled.

The little toddler while at play in the backyard sandpile soon learns that energy, grit and perseverance are needed for it to dig its way up to the top of the heap.

And so it is with the operating engineer. He must have a heap of mental "sand" before he is equipped, for instance, to assume charge of a badly run-down plant where the stockholders' only policy is apparently to squeeze every possible dollar out of the property, and to refuse to put aside anything for its repairs and maintenance.

There are certain individuals who think that it requires "sand" to burglarize a man's home in the dead of night; to take a "dare" or needlessly risk their lives; or, knowing that the boiler plates are badly pitted or are otherwise dangerously defective, will continue to operate the boiler. Running risks when there is nothing to be gained merely indicates rashness and recklessness.

The "sand" that counts is possessed by the engineer who perseveres under almost overwhelming obstacles and wins out; he has the required grit, and backs it up by hard work. He does not recognize luck, nor chance; he gets busy and sticks to the job—and this does not mean coming on duty at 9 a.m. and knocking off at 4 p.m.

Another test for "sand," from which some engineers shrink, is that of permitting central-station men to run a test of the steam apparatus. The management takes the ground that if the central-station men can show up anything about the plant that is unknown to the management, it is high time to bring it to light.

Have you, Mr. Isolated Plant Engineer, got the "sand" to put your station to the test, or is it possible that the showing would endanger your position?

If this is the case, you need "sand," not for hot bearings, but for stiffening up your backbone, for successfully coping with your engineering problems, for creating courage to tell the management just how much needless waste is going on in the plant, and how it can best be stopped.

Pumping Plant at Sloss Iron Mines

By C. A. Tupper

A 750-kw. turbine plant supplying electrical energy to an underground pumping station equipped with four-stage centrifugal induction-motor-driven pumps installed solely for the purpose of keeping mine free from water.

To provide a modern electric generating plant solely for the purpose of keeping a mine free from water is unusual; but this was done by the Sloss-Sheffield Steel & Iron Co., Birmingham, Ala., at what are known as the "Sloss" workings on Red Mountain in Jefferson County.

Heavy Intermittent Inflows of Water

Included in these workings are two slopes of about 23-deg. pitch. The lower, designated as No. 1, is 2400 ft. southwest of No. 2. Both lie directly across from Bessemer, Ala., about 1½ miles distant. In common with other slopes on Red Mountain much trouble was caused by heavy inflows of water, that usually broke in from the overlying strata through fractures in the hanging wall. These occasional floodings were originally of relatively short duration, and little difficulty was experienced during most of the year in keeping the workings dry.

In 1909-10 the condition of No. 1 mine was greatly impaired by heavy falls of top rock, which opened up numerous channels of water and forced a shutdown of the mine. Additional pumps and the necessary pipe lines were installed, but the flow of water was so steady and of such great volume that the direct-acting steam and air pumps proved inadequate. Consequently, F. W. Hausmann, mechanical engineer of the company, in conjunction with M. J. Lide, consulting engineer, prepared the plans for a complete electrically driven pumping plant.

The Power Equipment

The pumping plant comprises a power house, in which is installed a steam-turbine generator unit of 750 kw. capacity, and an underground pumping station equipped with two 10-in. four-stage centrifugal pumps, each direct-connected to a 450-hp. three-phase 60-cycle squirrel-cage induction motor. The turbine, which operates at 3600 r.p.m., is supplied through a 6-in. feeder with steam at 125-hp. gage pressure from a battery of water-tube boilers. In its various details standard practice is followed. Three-phase, 60-cycle currents are delivered by the generator at 2300 volts. Excitation for the alternator is supplied by an engine-driven dynamo of 15 kw. at starting and by a motor-driven set of the same size while running.

The turbine is operated condensing, and the arrangements for this are somewhat unusual. All of the water pumped from the mine is discharged into a large circular concrete reservoir, with suitable gates for excess flow, situated on the side of the mountain above the power house. From this reservoir injection water at 60° F. is drawn to a 36-in. Tomlinson barometric condenser, which maintains a vacuum of approximately 28 in. referred to a 30-in. barometer. The piping and other arrangements at the power house, with provision for atmospheric exhaust when desirable, are shown in the sectional view of the station, Fig. 2.

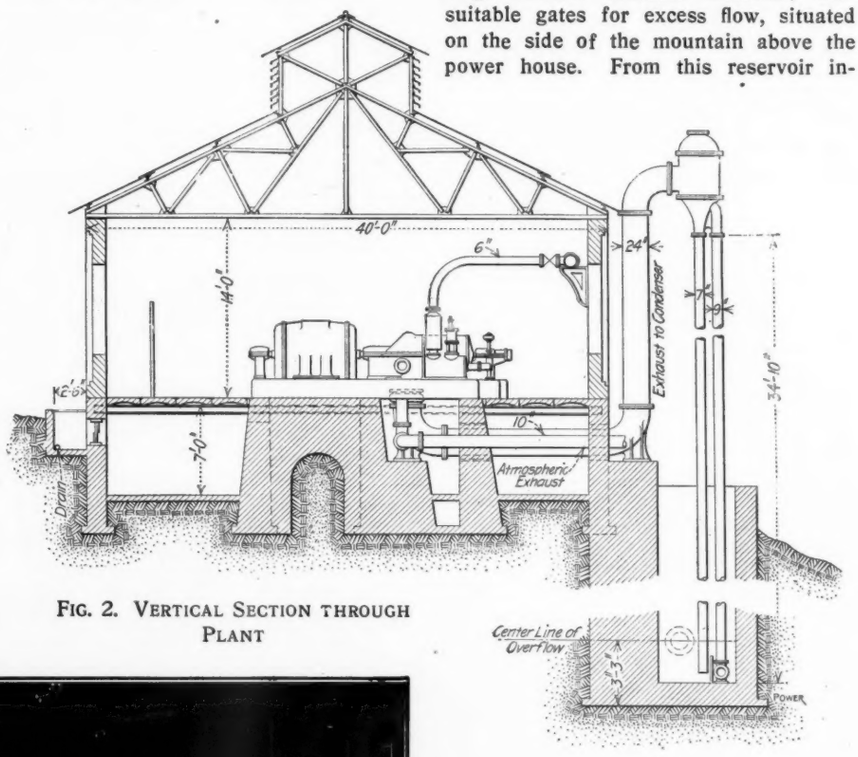


Fig. 2. Vertical Section through Plant

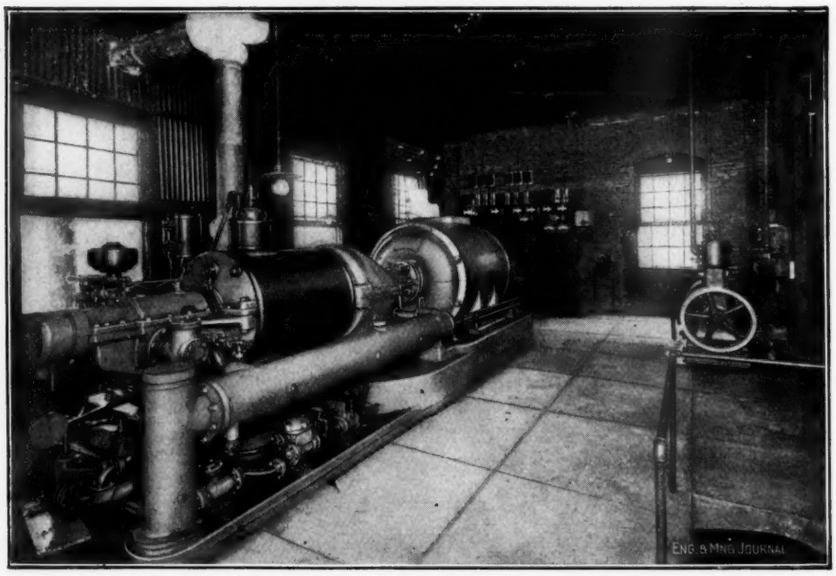


Fig. 1. Turbine Generating Unit in Power Plant

From the switchboard the alternating current generated is carried to the mine opening by means of a three-phase overhead line and thence through a three-conductor lead-covered steel-armored cable to the pump motors.

Starting the Motors

For convenience in operation, the engineers' plans provided for starting the

motors and stopping them directly from the power house. To this end induction-motor panels were embodied in the power-house switchboard, from which, by means of suitable gearing, are manipulated auto-starters situated in the basement. In addition, at each motor is provided an emergency oil switch, so that, in the event of an accident, the operator in the mine is not dependent upon the power-plant engineer to enable him to shut down. There is, however, direct telephone connection. In starting, a pump motor can be brought up to full speed quickly, with the other motor either running or shut down, and the momentary fluctuation in voltage is slight.

The underground pumping station and a permanent sump of 1,500,000 gal. or more are situated about 1600 ft. from the slope mouth. At this point the pumps have to operate against a total vertical head, including suction, of 655 ft. The rated capacity of each pump at 1130 r.p.m. is 1800 gal. per minute.

Electrically, there was some difficulty at the start. As is customary in systems containing a combination of overhead and underground circuits, high potentials occurred, due to resonance effects, which on several occasions produced pin-hole punctures in the insulation of the motor windings. This difficulty, however, was remedied by grounding the neutral point of the generator and installing aluminum-cell, electrolytic-type lightning-arresters.

For the illustrations and data here presented, the author is indebted to Jesse Adkins, Birmingham manager of Allis-Chalmers Co., which built the power and pumping machinery, and to F. W. Hausmann, engineer of the Sloss Sheffield Steel & Iron Co.

Answers to Study Questions

1. A horsepower is equal to 0.746 of a kilowatt. One pound of steam per kilowatt would be 0.746 of a pound per horsepower if the unit were of 100 per cent. efficiency. But if the unit had an efficiency of only 90 per cent., one horsepower would produce only

$$0.746 \times 0.90 = 0.6714 \ kw.$$

One pound per kilowatt would therefore mean 0.6714 lb. per horsepower used in producing it under these conditions and 16.5 lb. per kilowatt-hour would mean

$$0.6714 \times 16.5 = 11.0781 \ lb. \ per \ hp.\text{-}hr.$$

Proof: 11.0781 lb. of steam produce

$$746 \times 0.90 = 671.4 \ watts$$

or

$$\frac{11.0781}{671.4} = 0.0165 \ lb.$$

of steam produce 1 watt and

$$0.0165 \times 1000 = 16.5 \ lb.$$

of steam produce 1000 watts or a kilowatt.

The formula is

$$\frac{W}{Hp.} = \frac{W}{Kw.} \times \frac{746E}{1000}$$

where

$\frac{W}{Hp.}$ = Water rate per horsepower;

$\frac{W}{Kw.}$ = Water rate per kilowatt;

E = Efficiency of the unit.

2. To produce a pound of dry saturated steam at 135 lb. pressure from water at 32 deg. requires 1191.6 B.t.u. (values are from the Marks-Davis steam tables).

To heat a pound of water from 32 to 160 deg. requires 127.86 B.t.u. To make the pound of steam from feed water of 160 deg. requires therefore

$$1191.6 - 127.86 = 1063.74 \ B.t.u.$$

To evaporate a pound of water "from and at 212 deg.," that is, to evaporate at atmospheric pressure a pound of water already at the boiling point at that pressure, requires 970.4 B.t.u. Under these conditions, therefore, there would be evaporated by the same amount of heat

$$\frac{1063.74}{970.4} = 1.0962$$

times as much water as from feed of 160 into steam of 135 lb. pressure.

If, then, one pound of coal evaporates 8.5 lb. of water under the stated conditions, it would evaporate

$$8.5 \times 1.0962 = 9.3177$$

from and at 212 deg.

The formula is

$$E_e = E_a \frac{H - h}{970.4}$$

where

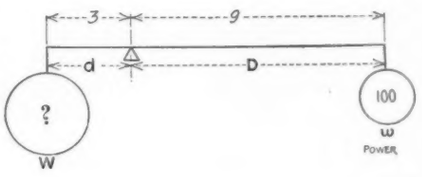
E_e = Equivalent evaporation from and at 212 deg.;

E_a = Actual evaporation under given condition;

H = Total heat of dry saturated steam of given pressure;

h = Heat of liquid at given feed-water temperature.

3. The product of each weight and its distance from the fulcrum or point over which the lever turns must be the same.



The given weight, 100 lb., is 9 ft. from the fulcrum. The product of the weight and distance is

$$100 \times 9 = 900$$

The missing weight multiplied by 3 must equal 900, then

$$900 \div 3 = 300$$

is the missing weight.

Proof:

$$100 \times 9 = 900$$
$$300 \times 3 = 900.$$

The formulas are

$$W = \frac{wD}{d} \qquad w = \frac{Wd}{D}$$

$$D = \frac{Wd}{w} \qquad d = \frac{wD}{W}$$

where

W = Greater weight;

w = Smaller weight;

D = Greater distance;

d = Lesser distance.

It makes no difference whether the distances are inches, feet or miles, so long as they are both taken in the same units.

4. One pound of force will accelerate the velocity of one pound of matter at the rate of 32.16 ft. per second.

For each pound of matter falling a pound of force is pulling downward.

Starting from rest, the velocity at the end of one second will be 32.16 ft. per second; at the end of 2 sec., 64.32, etc.

At the commencement of the first second the velocity is zero; at the end, 32.16 ft. per second. Since the acceleration is uniform the average velocity for the second will be

$$32.16 \div 2 = 16.08 \ ft. \ per \ sec.$$

At the end of 4 sec. its velocity would be

$$4 \times 32.16 = 128.64$$

and its average velocity

$$128.64 \div 2 = 64.32 \ ft. \ per \ sec.$$

Falling 4 sec. at this average velocity, it would drop through

$$4 \times 64.32 = 257.28 \ ft.$$

The acceleration 32.16 ft. per second being that due to gravity is called g. Calling the time in seconds t and the distance d, the formula is

$$d = \frac{t^2 g}{2}$$

It would take 100 lb. per square inch *difference* in pressure between the contents of the boiler and the atmosphere to blow the valve wherever the boiler were. As the gage measures this difference of pressure, it would indicate the same pressure when the valve lifted whether the boiler were at sea level or on a mountain.

The N. E. L. A. *Bulletin* is asked if any member has been successful in securing power in laundries. If more power is sold to the average laundry, speaking for ourselves, the editorial force of this paper will have to seek refuge in overalls and jumper. Our newest negligee has shown a dangerous difference of potential between the primary and secondary "terminals," its dynamic force is well nigh spent, and it has the appearance of having been "shocked" beyond resuscitation.

Adjustment of Electric Lighting Rate

Extracts from the reports of the Wisconsin Railway Commission regarding the influence of various fixed charges upon the rates and a paper by Prof. Cory showing the influence of the load factor upon the total cost.

In estimating the costs of construction, operating expenses, depreciation, valuation, etc., of power plants and all factors to be considered in the establishment of equitable rates of services, the reports of the Wisconsin Railroad Commission have been almost universally adopted in principle by other state commissions, municipal public-utility boards and engineers as an accurate basis for decisions. Also, a recent address by Prof. Cory, of the University of California, upon the adjustment of rates, before the League of California Municipalities at Santa Barbara, offers new and instructive data. Before taking up Prof. Cory's paper, extracts will be given from the reports of the Wisconsin Railway Commission.

Wisconsin Railroad Commission—Valuation of Plants

Taxes, depreciation and interest on the investment are expenses which a public utility must meet; they should be borne by the consumer; otherwise the burden of cost does not fall where it belongs. Again, these so called "fixed expenses" depend directly upon the investment represented in the plant. To make each department bear its proper burden of expense, it is necessary to determine upon a fair valuation not only of the total property but of each department.

In estimating the costs for municipal as well as for privately owned plants, it seems necessary to consider the operating expenses, depreciation, taxes and interest on the investment. The two former are always present and must be met, no matter by whom the plants are operated. Taxes and interest charges may, in a sense, be dispensed with for municipal plants; on the other hand, both are evident in some form in all industrial activities. If such items as fixed charges are not considered by municipal plants in fixing rates for private consumers, it would seem that these consumers would be favored as against the tax payers. There does not, on the whole, appear to be any equitable ground upon which such charges can be entirely eliminated in any industry or in any connection with the services of any public utility.

Operating Expenses

Operating expenses may be divided into two classes: constant and variable expenses. Constant expenses are not often materially affected by the amount of business done, while variable expenses are affected by the amount of business done. From the point of view of rate making, since constant expenses depend upon the capacity, they should be distributed among the consumers, and since variable expenses depend on the output, they should be distributed according to the output. Under this apportionment, constant expenses assume the nature of a service charge and may either be directly applied as a service charge in the rates or may be used as the basis upon which to determine the minimum charge.

The electric-lighting business is such that a large proportion of the operating expenses are not directly proportional to the output. Since it is impossible to store electrical energy economically, the plant must be so designed and maintained as to be able to meet the maximum demand. Whether the consumer uses much or little current is of small consequence in determining the capacity of the plant. He has in his residence, store or office a certain number of lamps, and if he desires to burn all of them at one time, the plant must be able to supply him with sufficient current.

Variable expenses, including such items as fuel, oil, waste and certain repairs and labor, are directly proportional to the power sold; they increase as the output increases and decrease as it becomes less. There are, however, certain items which can be called neither all capacity expense nor all output expense, but must be divided between the two groups.

Distribution expenses are but slightly affected by output and are, therefore, largely capacity expenses; general expenses are entirely capacity costs, not influenced by output. Depreciation and interest on the investment are overhead expenses, following the general practice, and are apportioned between output and capacity on the basis of the total expenses. Direct expenses include the generation, distribution and consumption charges.

The practice of charging operating expenses to the construction account may have serious consequences. It may lead, first of all, to erroneous conclusions as to the financial condition of a plant and the sufficiency of the revenues derived from operation. If expenditures are wrongly charged to construction, operating expenses will appear correspondingly less, and the margin between revenues and expenses proportionately wider; and the showing of net profit augments fictitiously to an equal extent.

Depreciation

Depreciation is that loss or shrinkage of value which inevitably occurs from time to time in the equipment of the plant; it may be due to wear and tear, to age, to the march of modern invention or to inadequacy. The establishment of a depreciation fund, in short, is intended to keep the original investment intact. Bearing this in mind, depreciation might reasonably be defined as the amount which makes up the difference between the value of the plant at any period after construction, although kept in good running condition by ordinary repairs, and the original cost value of the plant.

Rate Establishment

The rates for electric energy should be based upon the cost of service, under which each particular consumer contributes to the revenues of the company in proportion to the cost to the plant of such service. The cost, in turn, depends upon the hours of daily operation and the rates must be based on the customer's daily use of this connected load. The actual rate in cents is dependent upon the facts in each case.

Every consumer calls into use a certain investment, regardless of the amount of his consumption. Even should he consume nothing, he would still have to be carried on the books and a certain amount of equipment would have to be held in readiness to serve him. Such fixed expenses properly constitute a definite consumer charge. In order that every consumer shall pay his share of the expenses, the expenses of the plant must be apportioned between the capacity and output costs, to determine what part of each class of expense should be charged against the consumer.

Prof. Cory's Paper

To apply the methods of obtaining approximately the cost of service to each consumer, along the lines indicated in the foregoing, the segregated costs, dealing separately with the fixed and variable expenses as affected by the load factor as well as the amount of electric energy used by each customer, have been worked out for two typical electrical lighting systems on the Pacific coast. These will be denoted as systems 1 and 2, the former having its power generated with steam, and the latter receiving its power at a substation outside of the city limits, stepping down from 60,000 volts to the voltage of commercial distribution.

Load Factor

Probably no point is of such serious consequence in connection with the operation of a municipal lighting system as the load factor, as most of the consumption is residence lighting, the period of use being usually not more than an average of two hours nightly out of the 24-hour day. Again, there is a wide difference between the maximum demand and the average load for the year, caused by the difference in the seasons.

As an illustration, Fig. 1 shows the load curve of system No. 2 on June 30, 1910, giving a maximum load of 1619 kw. at 9 p.m., and lasting but a brief interval. The average load for 24 hr.

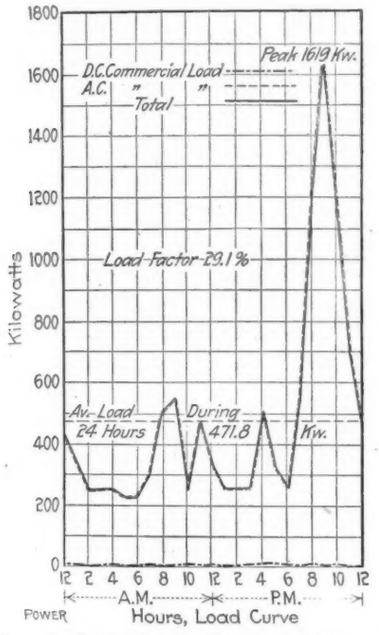


Fig. 1. Peak Load, Summer Months

was 471.8 kw., making a load factor of 29.1 per cent. for the day. Fig. 2 is the load curve of the same system six months later, on Dec. 31, 1910. The actual peak was 2363 kw., or almost 50 per cent. greater than on June 30. The load above 1200 kw. lasted for 5½ hr.; the average load for the 24 hr. was 920.7 kw., an increase of nearly 100 per cent. over that in June; and the load factor for the day was 38.9 per cent.

An annual load factor for such electric-lighting service of from 20 to 30 per cent. is not uncommon, while, in comparison, extensive transmission systems, often including a number of hydro-electric as well as steam-driven central stations, sometimes have a load factor of between 70 and 75 per cent. This, of course, is due to the extensive application of electric energy for power in the operation of transportation systems, industrial plants, mines, etc.

Plant Investments

Another point in connection with the construction and operation of municipally owned lighting systems, is the usual rapid growth of such systems; the increased investment demanded each year being met ordinarily by a new bond issue.

In the case of system No. 2, the additions varied from a minimum of $35,000 to a maximum of $120,000 per year; the total investment increasing in seven years from $155,000 to $565,000, approximately 3½ times the original outlay.

If there be a surplus under favorable conditions, it may be used for short periods to do needed construction work and

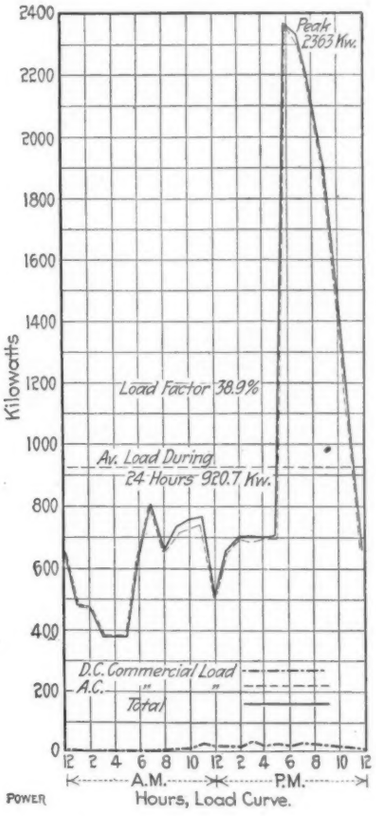


Fig. 2. Peak Load, Winter Months

later, the cost of such work may be met by a bond issue, reimbursing the surplus fund of the electric-lighting system. Also, in such cases it may be proper to expend for new construction, funds which properly must be set aside each year to cover depreciation, provided such accounts are always properly credited on the books of the system and the amounts replaced at such times as a new bond issue renders available such funds.

Fuel Cost

Figures by C. R. Weymouth have been used in determining the fuel cost at the switchboard of the steam plant per kilowatt-hour at various load factors. These are for condensing, direct-connected steam-driven units based on plants installed at Pacific coast railway-terminal points. The oil is assumed as having 18,850 B.t.u. per pound and weighing 336 lb. per barrel. The kilowatt-hours per barrel of oil from such source, for a 15,000-kw. condensing plant, operating 24 hr. per day, are:

Load Factor, Per Cent.	Kilowatt-hours per Barrel of Oil
100	197
50	155
33	125

The cost of fuel with oil at 70c. and also at $1 per barrel per kilowatt-hour, as affected by the load factor, is shown in Fig. 3. This indicates plainly the increased cost of fuel resulting from a low average daily load.

Plant Statistics

The figures given for the two particular electric-lighting systems selected

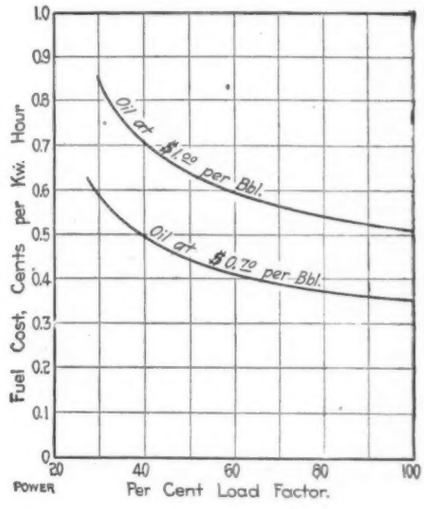


Fig. 3. Variation of Fuel Cost with Load Factor

are only relative, and do not indicate absolutely the average costs per kilowatt-hour, especially as delivered to consumers' meters, in other plants operating under entirely different conditions.

System No. 1

The relation between the investment per kilowatt in the generating stations, distributing system and electrical meters, based on the peak and the average load, is shown in Table 2, which clearly indicates the disadvantage of a low load factor.

In Table 3 the average rate of depreciation upon the generating station is taken at 5 per cent., so determined by considering separately the estimated life of the different parts of the station, inclusive of buildings, foundations and the steam and electrical machinery. The total generating cost per kilowatt-hour at the plant is less than one-half as much at 100 per cent. load factor as at 35 per cent. load factor, the actual fig-

TABLE 1

Item	System No. 1	System No. 2
Character of generating station	Steam plant	From water and steam power, transmission system
Cost of fuel per barrel	$1.00	.....
Installed capacity, kilowatts	1,750	.....
Peak load for year, kilowatts	1,200	2,500
Average load for year, kilowatts	415	750
Load factor for one year, per cent	34.6	33⅓
Efficiency of distribution system from switchboard to consumers' meters, per cent	65	70
Aggregate length of distribution system, miles	75	overhead, 100 underground, 4.5
Average cost, distribution system per mile	$3,430	$3,050
Number of customers	3,057	7,250
Number of customers per mile of distribution system	41	69
Number of pole transformers	552	424
Aggregate capacity of transformers, kilowatts	2,179	4,167
Average capacity per transformer, kilowatts	4	10
Total valuation of system	$560,000	$577,000
Kilowatt-hours steam plant switchboard per year	3,635,500	.....
Kilowatt-hours, substation switchboard per year	....	6,570,000
Kilowatt-hours delivered to customers' meters per year	2,363,000	4,600,000
Average generating cost per kilowatt-hour, steam plant switchboard, cents	1.91	.....
Average generator cost per kilowatt-hour delivered to customers' meters, cents	2.94	.....
Cost per kilowatt-hour substation switchboard:		
100 per cent. load factor, cents	.....	0.75
20 per cent. load factor, cents.	.....	2.25
Cost at substation switchboard per kilowatt-hour delivered to customers' meters:		
30 per cent. load factor, cents	.....	3.21
Average total cost per kilowatt-hour delivered to customers' meters, cents	6.32	6.34

TABLE 2

Portion of System	Investment	Investment per Kilowatt		
		Installed Capacity	Peak Load	Average Load
Generating station	$253,000	$144.44	$210.65	$609.50
Distribution system	257,000	146.90	214.17	619.00
Electric meters	50,000	28.55	41.63	120.50
Total	$560,000	$319.89	$466.45	$1349.00

ures being 0.9c. per kilowatt-hour, with the best character of load and 1.91c. per kilowatt-hour, with the average load slightly above one-third the peak load.

TABLE 3. STATION CHARGES

Item	Yearly Total	Per Kilowatt-Hour		
		100% Load Factor	70% Load Factor	35% Load Factor
Interest, 5 per cent	$12,650	0.12	0.17	0.34
Taxes, 1.6 per cent	4,050	0.04	0.06	0.11
Depreciation, 5 per cent	12,650	0.12	0.17	0.34
Fuel	.....	0.51	0.56	0.79
Operation and maintenance	12,000	0.11	0.16	0.33
Total generating cost per kilowatt-hour at plant, cents	.....	0.90	1.12	1.91
Total generating cost per kilowatt-hour delivered to customers' meters, cents	.....	1.38	1.73	2.94

The annual depreciation for the distribution system, as given in Table 4, has been taken at 8½ per cent. It will be noted that the total distribution cost per kilowatt-hour delivered to customers' meters is nearly three times as great at 35 per cent. load factor as at the maximum load factor.

TABLE 4. DISTRIBUTION CHARGES

Item	Amount	Per Kilowatt-Hour		
		100% Load Factor	70% Load Factor	35% Load Factor
Interest, 5 per cent	$12.850	0.12	0.17	0.35
Taxes, 1.6 per cent	4,120	0.04	0.06	0.11
Depreciation, 8.5 per cent	21,850	0.21	0.30	0.59
Operation and maintenance	23,000	0.22	0.31	0.62
Total distribution cost per kilowatt-hour at plant, cents	.....	0.59	0.84	1.67
Total distribution cost per kilowatt-hour delivered to customers' meters, cents.	.....	0.91	1.29	2.57

In Tables 5 and 6 the total average cost per kilowatt-hour delivered to consumers' meters at 100 per cent., 70 per cent. and 35 per cent. load factor are 2.57c., 3.4c. and 6.32c. respectively, based upon the summations of the tables and including the total metering cost per kilowatt-hour delivered to customers' meters. These three comparative costs indicate why the consumer of electric energy, even though such consumption is reasonably small in magnitude, is justly entitled to a decidedly low rate if the electric energy used by him is utilized at a high daily average load; in other words, if his demand for service is such that the load factor is high. In this instance, if the load factor is uniform throughout the 24 hr., his rate may be properly 2.57c. per kilowatt-hour, increasing to 3.4c. if the average load is 70 per cent. of the maximum, and to 6.32c. if it is but 35 per cent.

TABLE 5. ANNUAL METERING, BILLING AND COLLECTING

Item	Amount	Per Kilowatt-Hour		
		100% Load Factor	70% Load Factor	35% Load Factor
Interest, 5 per cent	$2,500	0.02	0.03	0.07
Taxes, 1.6 per cent	800	0.01	0.01	0.02
Depreciation, 8 per cent	4,000	0.04	0.05	0.11
Operation and maintenance	12,000	0.11	0.16	0.33
Total metering cost per kilowatt-hour at plant	.....	0.18	0.25	0.53
Total metering cost per kilowatt-hour delivered to customers' meters	.....	0.28	0.38	0.81

TABLE 6. TOTAL COST OF ELECTRIC SERVICE PER KILOWATT-HOUR TO CUSTOMERS' METERS AT DIFFERENT LOAD FACTORS

Item	Per Kilowatt-Hour to Customer at		
	100% Load Factor	70% Load Factor	35% Load Factor
Generation, cents	1.38	1.73	2.94
Distribution, cents	0.91	1.29	2.57
Metering, cents	0.28	0.38	0.81
Total cost (average), cents	2.57	3.40	6.32

System No. 2

The total investment in system No. 2 and the investment per kilowatt-hour peak and average yearly load is shown in Tables 7 and 8. From these figures it will be noted that the total investment per kilowatt for the average load in this system is only a little more than one-half the corresponding investment in system No. 1, due to the fact that no investment is required for the generating station in system No. 2.

TABLE 7. TOTAL INVESTMENT

Substation:		
Real estate	$22,000	
Buildings	33,500	
Apparatus	87,500	$143,000
Distribution:		
Overhead	274,500	
Underground	44,000	318,500
Meters	.....	115,500
Totals	.....	$577,000

TABLE 8. INVESTMENT IN SUBSTATION, DISTRIBUTION SYSTEM AND ELECTRICAL METERS PER KILOWATT-HOUR PEAK AND AVERAGE YEARLY LOAD

	Total Investment	Investment per Kilowatt	
		Peak Load, 2500 Kilowatts	Average Load, 750 Kilowatts
Substation	$143,000	$57.20	$190.60
Distribution	318,500	127.50	424.70
Meters	115,500	46.20	153.90
Total	$577,000	$230.90	$769.20

Table 9 shows the distribution cost per kilowatt-hour delivered to customers' meters at 100 per cent. load factor.

In Table 10 are given the annual metering, billing and collecting costs per kilowatt-hour on the substation switchboard and at the consumers' meters for different load factors.

In system No. 2 the cost of electrical energy from the transmission lines represents an average monthly cost to the customer of $1.70; the corresponding distribution cost, $1.15, and the cost of metering, etc., 49c., amounting to a total average monthly cost per customer of $3.34. Comparing Table 6 with Table 11, which gives the total cost of electric service per kilowatt-hour to the customers' meters, it will be noticed that the average monthly cost per customer is less in system No. 2 than in system No. 1, because of the greater number of meter connections.

TABLE 9. ANNUAL DISTRIBUTION CHARGES AND COST PER KILOWATT-HOUR ON SWITCHBOARD AND AT CUSTOMERS' METERS FOR DIFFERENT LOAD FACTORS

Item	Amount	Per Cent.	100 Miles of Distribution System			
			Yearly Charge	100%	70%	30%
Interest	$461,000	5	$23,050	0.11c.	0.15c.	0.35c.
Taxes	46,000	1.6	7,376	0.03c.	0.05c.	0.11c.
Depreciation:						
Buildings	33,500	3	1,005			
Electrical apparatus	87,500	5	4,375			
Distribution, overhead	274,500	8½	23,333			
Distribution, underground	44,000	4	1,760			
	$439,500	6.94	$30,473	0.14c.	0.20c.	0.46c.
Operation and maintenance	.....	....	40,000	0.18c.	0.26c.	0.61c.
Total distribution cost per kilowatt-hour at substation	.....	....	.....	0.46c.	0.66c.	1.53c.
Total distribution cost per kilowatt-hour delivered to customers' meters	.....	....	.....	0.66c.	0.94c.	2.19c.

TABLE 10. ANNUAL METERING, BILLING AND COLLECTING, ETC., CHARGES

Item	Amount	Per Cent.	Yearly Charge	Cost per Kilowatt-hour		
				100%	70%	30%
Interest	$115,500	5	$5,775	0.03c.	0.04c.	0.09c.
Taxes	115,500	1.5	1,850	0.01c.	0.01c.	0.03c.
Depreciation	115,500	7	9,240	0.04c.	0.06c.	0.14c.
Operation and maintenance	.....	...	26,000	0.12c.	0.17c.	0.40c.
Total metering cost per kilowatt-hour at substation	.....	...	.....	0.20c.	0.28c.	0.66c.
Total metering cost per kilowatt-hour delivered to customers' meters	.....	...	.....	0.28c.	0.40c.	0.94c.

TABLE 11. TOTAL COST OF ELECTRIC SERVICE PER KILOWATT-HOUR TO CUSTOMERS' METERS AT DIFFERENT LOAD FACTORS

Item	Per Kilowatt-hour to Customer at		
	100% Load Factor	70% Load Factor	30% Load Factor
Cost of power at substation	1.07c.	1.50c.	3.21c.
Distribution	0.66c.	0.94c.	2.19c.
Metering	0.26c.	0.40c.	0.94c.
Total	1.99c.	2.84c.	6.34c.

Condenser Head Broken by the Gasket

By W. G. Freer

A few years ago it became necessary to remove the head from a condenser in a large central station, for the purpose of cleaning the tubes. The condenser was in two sections, each probably 50 in. inside diameter, with flanges at the end about 1 in. on the radius. The head was about 1 in. thick, of cast iron, and dished considerably to stiffen it. The dishing sprang from the inner edge of the flange, and was sharp and clearly defined, the flat border being of the same width as the flange on the cylinder.

On removing the head the gasket stuck and was broken, making it unfit for further use. When the head was about to be replaced it was found that there was not sufficient sheet packing to make a gasket, and, as a substitute, a soft piece of rubber gas tubing was laid on the flange just inside of the bolts, and the ends lapped, making what is commonly called an inside joint. The head was bolted on and the pump started, to test the job, which appeared to be all right, and the engine was reported ready for service.

This being a night watch job, the engine was not ordered on the line until the next afternoon, when, as the station load increased, it was brought up to speed and the load thrown on as usual.

Shortly after this the engineer on watch made a tour around the plant, and upon reaching the condenser he saw water flowing down over the outside of the head. Upon closer examination he discovered that it was coming from a crack which extended for some 18 or 20 in. along the inner circle of the flange. He immediately stopped the circulating pump and opened the exhaust to the atmosphere, as the engine was capable of carrying the load when running noncondensing.

The fracture was reported and an investigation held to determine the cause and place the blame. The evidence all tended to prove that due care had been exercised in screwing the bolts gradually and equally all around, and as the head was generally thought to be tight, it was about to be declared an unavoidable accident, due to poor design, when one of the engineers suggested that the gasket had been the cause of the trouble. He was directed to explain, and, as he had been in charge of the job and was the man to bear the blame for any mistake, considerable interest was manifested in what he had to say.

He pointed out that the narrow gasket in its position close to the bolts, placed the head in the class with a beam supported at the ends and uniformly loaded. The old gasket had been of sheet packing which was almost entirely of canvas, and hard, covering the full width of the flange. He claimed that the head on this seating was in the class with a beam rigidly fixed at both ends, a much stronger construction.

This line of reasoning was followed by the chief stating that he had noticed that the head appeared to spring slightly more to the pulsations of the pump than usual, when the job was tested, but that he had become so accustomed to seeing the head breathing that he had passed it as imaginary and had not given it the careful consideration that it would have received had it been a new condition.

The investigation ended here and nothing happened to the men at fault, but the problem was discussed by the engineers and foremen and all came to the conclusion that the gasket was the cause. Inside joints are all right, but one should be sure the head is strong enough. If there is any doubt of this, a full flange joint should be used; it is stronger.

The Kienast Steam Turbine

Description and results of tests on the Kienast steam turbine. In this type the blading on the wheel is so arranged as to provide three concentric passages for the steam; that is, the steam passes axially through the blading and by means of reversing passages is returned and made to act upon the same wheel three times.

The machine is adapted especially to the smaller capacities.

This is one of those turbines, adapted especially to smaller capacities, in which the steam is made to act a number of times successively upon the same wheel by being passed across it axially through the blading and returned by reversing passages to act again upon the blading from the opposite side. The peculiarity of the Kienast system is that the blading is divided radially into a number of chambers, usually three, by fins inserted into the concave inner faces of the blades, as shown in Fig. 1. The turbine is of the partial-admission type, the outlet of the admis-

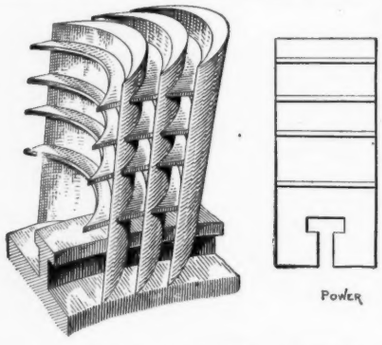
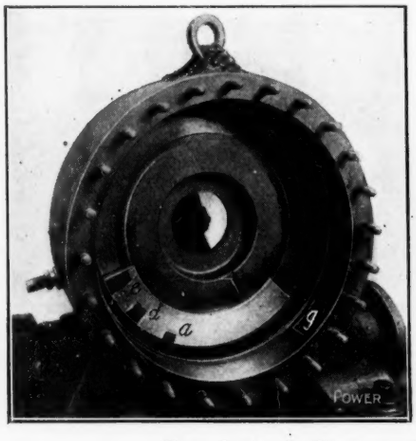
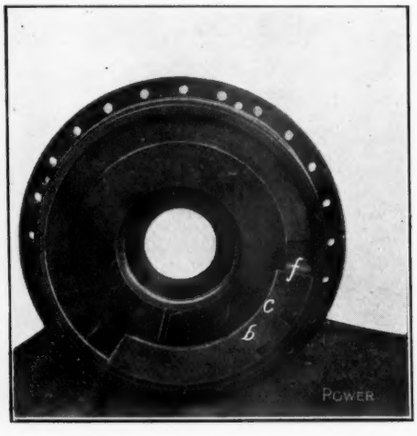


FIG. 1. METHOD OF ATTACHING BLADES

sion nozzles being shown at *a* in Fig. 2. In this nozzle, shown also at *a* in Fig. 4, the steam is expanded from the initial to the back pressure, and with the velocity thus acquired impinges upon the wheel, which absorbs some of its energy and discharges it at a reduced velocity into the port *b*, Fig. 3, shown diagrammatically at *b*, Fig. 4. The width of this





FIGS. 2 AND 3. SHOWING STEAM PASSAGES IN CASING

nozzle is sufficient to span only the first or outer division of the blade, as shown in the section *AA*, Fig. 4, but the reversing passage, of which *b* is the entrance, increases in depth as it progresses until at its exit, *c*, Figs. 3 and 4, it spans two of the divisions, as shown in the section *BB*, Fig. 4. There is no expansion into this increased volume as the steam has been already expanded to the counterpressure; but the increased cross-section permits the passage of the same volume of steam at the diminished velocity. The reversing passage connecting the ports *d* and *e* deepens progressively until at its exit *e*, section *CC*, Fig. 4, it spans all three divisions. By its final impact the velocity of the jet is reduced so that the residual energy which it contains is unimportant and it is discharged at *f* into the case and escapes through the exhaust passage *g*, Fig. 2.

Fig. 5 is a horizontal and Fig. 6 a vertical section through one of the earlier turbines of 50 hp. capacity. The wheel *W* was at that time made by clamping the blades between chrome-steel disks riveted together as shown, but the blades in the later construction have T-slots at their lower extremities and are strung upon a disk having a corresponding T-rail upon its periphery as shown in Fig. 1. The turbine shown has two sets of nozzles, *NN*, Fig. 5. There is, however, no general high-pressure steam chamber attached to or forming a part of the case. Steam is admitted through the throttle valve *H* and the governor to the chamber *J* connecting with the nozzle *N*, and is taken from this chamber by means of the pipe *K* passing under the turbine to the nozzle chest *L* supplying the other nozzle. For light loads this nozzle may be shut off by means of the valve *M*. The absence of any large chamber under high pressure and temperature avoids distortion of the case due to unequal expansion, the steam not being admitted beyond the small valve chests until after it has been expanded to the terminal pressure and temperature. In addition to the main governor, best seen in Fig. 7,

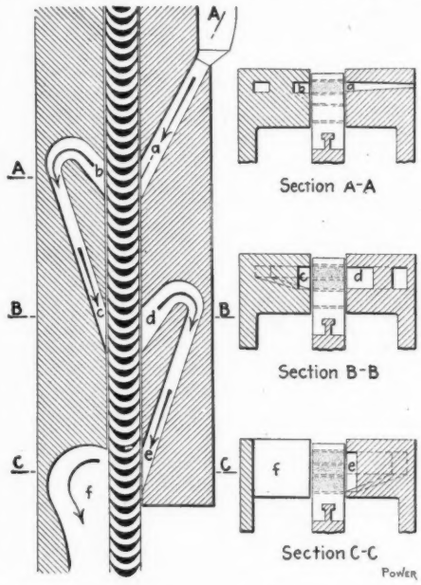


FIG. 4. INDICATING THE PATH OF THE STEAM

there is the usual safety stop *S*, Figs. 5 and 6.

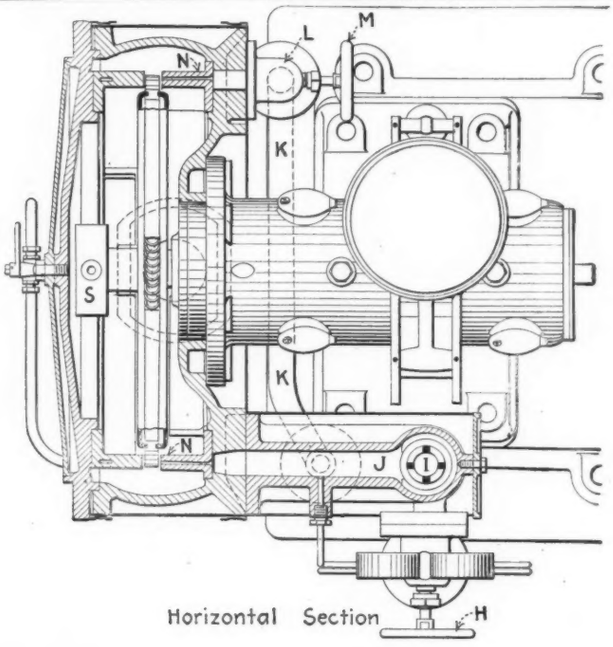
The blades and shaft are made of hard chrome-nickel steel, that for the blades being extruded in the desired crescent-shaped section, cut into lengths and slotted for the partitions. The nozzles are pressed into shape out of sheet steel, while the reversing passages are made in two parts out of pressed delta metal. The clearance axially, that is, between the nozzles and the blades, is 4 mm. (about 0.16 in.).

This system is best adapted for the high-pressure ranges of the expansion. The impracticability of making the reversing passages above a given size places an early limit upon the capacity which they can take care of when the volume of steam is increased by expansion to the low absolute pressures used with condensing turbines. For the lower-pressure stages it is necessary, therefore, to use additional wheels, but even in these the partitions in the blading are retained as tending to prevent the formation of secondary currents and to reduce windage. Fig. 8 shows a portion of one of the larger wheels of late construction.

In the spring of 1910, a 35-hp. turbine of this type built by Beige & Kuenzli, at

RESULTS OF STEAM CONSUMPTION TESTS

Number of Test	Steam Condensed, Lb. per Hr.	Internal Pressure, Lb. per Sq.In. Abs.	Initial Temperature, Degrees Fahrenheit	Saturated Steam Temperature, Deg. F.	Superheat, Deg. F.	Final Pressure, Lb. per Sq.In.	Final Temperature, Degrees Fahrenheit	Effective Turning Moment, Ft.-Lb.	R.p.m.	B.hp.	Weight of Steam, Lb. per Hr.	Stuffing-box Leakage, Pounds per Hour	Working Steam, Lb. per Hr.	Steam per B.hp.-hr.	Steam Required by Engine of 100% Efficiency per B.hp.	Rankine Efficiency,	Duration of Tests, Min.
1	279.35	28.44	256.46	247.28	9.18	14.57	208.4	0	2887	0	244.64	34.71	244.64	.....	.....	0	60
2	1240.85	149.05	480.2	357.62	122.58	14.67	309.38	59.31	2933	33.20	1190.16	5.06	1190.16	34.86	13.19	0.378	60
3	1375.29	167.97	505.4	367.16	118.24	14.64	325.40	72.33	2835	39.12	1325.70	.....	1325.70	32.95	12.49	0.379	60
4	634.75	75.23	311.36	307.58	3.78	14.79	210.2	15.47	3063	9.13	.....	.....	634.75	67.60	.....	.....	30
5	935.81	121.03	341.6	341.6	0	14.79	210.2	34.71	3061.5	20.38	.....	.....	935.81	44.65	.....	.....	30
6	1229.61	169.53	369.32	367.88	1.44	14.79	210.56	54.82	2994	31.31	.....	.....	1229.61	38.21	.....	.....	45
7	217.31	33.42	342.5	256.28	86.22	14.64	293.0	0	3057.2	0	240.23	.....	217.31	.....	.....	0	30
8	622.40	83.91	396.14	314.96	81.18	14.64	361.22	20.10	3057.2	11.80	573.04	49.36	573.04	47.28	17.41	0.368	30
9	866.17	126.30	482.9	344.84	138.0	14.64	320.0	37.97	3047.2	22.13	840.82	25.34	840.82	36.95	14.23	0.385	30
10	1159.30	166.83	493.34	366.62	126.72	14.64	311.36	57.86	3014.4	33.27	1109.71	49.59	1109.71	32.43	12.67	0.391	40
11	1132.85	167.68	528.44	366.98	161.46	14.64	346.28	57.50	3072.3	33.72	1090.98	41.87	1090.98	31.52	12.36	0.392	40
12	1106.40	167.54	441.32	366.89	74.52	14.64	388.4	69.43	1997.1	26.42	1102.0	4.40	1102	40.60	12.49	0.308	30
13	1086.57	164.70	442.22	365.54	76.68	14.64	374.0	58.94	2744	30.86	1075.55	11.02	1075.55	33.91	12.49	0.369	45
14	1115.22	167.54	442.76	366.89	76.0	14.64	367.16	58.58	3000	33.55	1093.18	22.04	1093.18	31.69	12.39	0.391	15
15	.....	167.83	501.44	367.07	134.46	14.64	318.56	56.92	3150	34.26	1110.81	.....	1110.81	31.52	12.60	0.40	5
16	.....	167.83	505.04	367.07	138.0	14.64	.....	56.05	3260	34.92	1108.61	.....	1108.61	30.86	12.54	0.406	5
17	1112.13	167.54	443.48	366.89	76.68	14.64	369.14	55.69	3330	35.46	1086.57	25.56	1086.57	29.82	12.32	0.413	10
18	1105.30	167.12	502.16	366.71	135.54	27.91	400.28	40.36	3018.4	23.29	1105.30	0	1105.30	46.12	16.28	0.353	25
19	1099.79	169.11	503.78	368.06	135.72	40.49	410.0	27.48	2988.6	15.75	1113.02	0	1099.79	67.93	19.69	0.290	30
20	1094.50	167.54	515.30	366.89	148.50	14.64	500.0	94.17	0	0	1094.50	0	1094.50	.....	.....	0	90



Horizontal Section

Taucha, near Leipzig, was tested by Prof. Josse in the mechanical laboratory of the Royal Technical College of Charlotten-

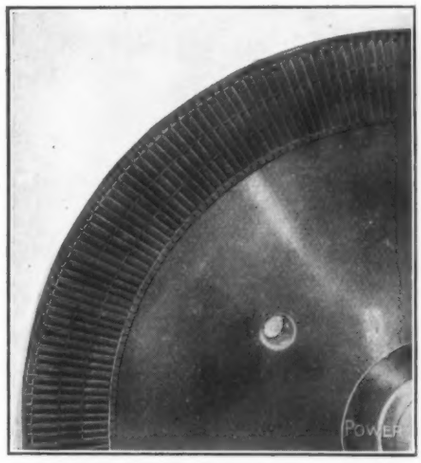
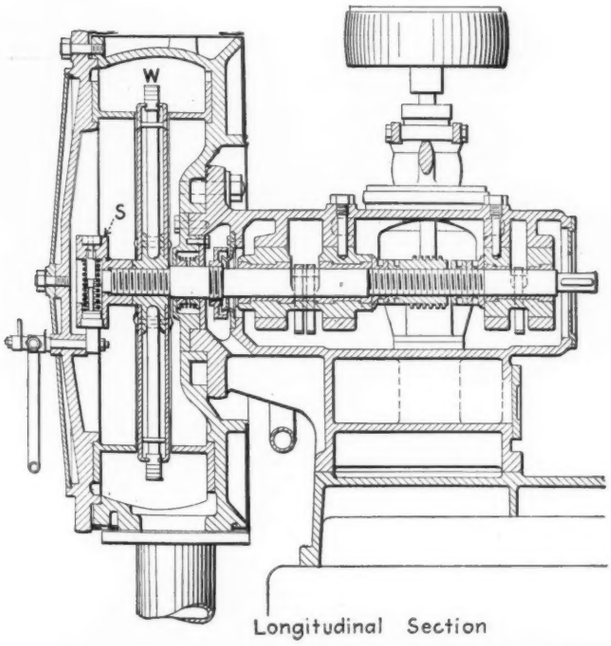
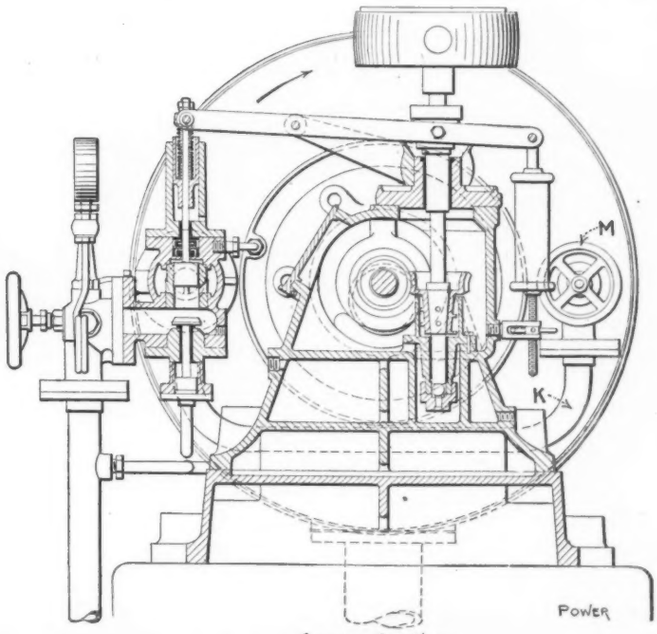


FIG. 8. PORTION OF WHEEL

burg, at Berlin, the results of and deductions from which are compiled in the ac-



Longitudinal Section



Cross Section

FIGS. 5, 6 AND 7. SHOWING SECTIONAL VIEWS OF THE KIENAST TURBINE

companying table. In the first three tests the turbine was equipped with a nozzle having a cross-section of 105 mm². (0.16 sq.in.). The weighed condensate amounted to more than would be discharged through a nozzle of this size and it was concluded that water from the stuffing-boxes had entered the turbine and mingled with it. The weights given in the table are, therefore, the computed weights and not those obtained from the scales. The rest of the tests were made with a nozzle having a minimum cross-section of 87.5 mm². (about 0.136 sq.in.).

Test 20 was made with the turbine standing still and the water turned off from the bearings to verify the correctness of the calculation for nozzle discharge. The quantities of condensate differed from the calculated values less than 1 per cent. on an average. On test 7, however, the quantity of steam obtained by calculation was greater than that obtained by measurement. The turbine had been running with full load and it is suggested that the steam took up heat from the metal at a greater temperature than that observed.

American patents have just been secured and are in the hands of G. A. Crayen & Co., 81 New St., New York City, for disposal.

Balanced Draft Furnace Regulation

By Warren O. Rogers

A system for maintaining atmospheric pressure in a boiler furnace.

The air delivered to the furnace is automatically controlled, also the gases escaping to the atmosphere, the former by the pressure built up in the furnace.

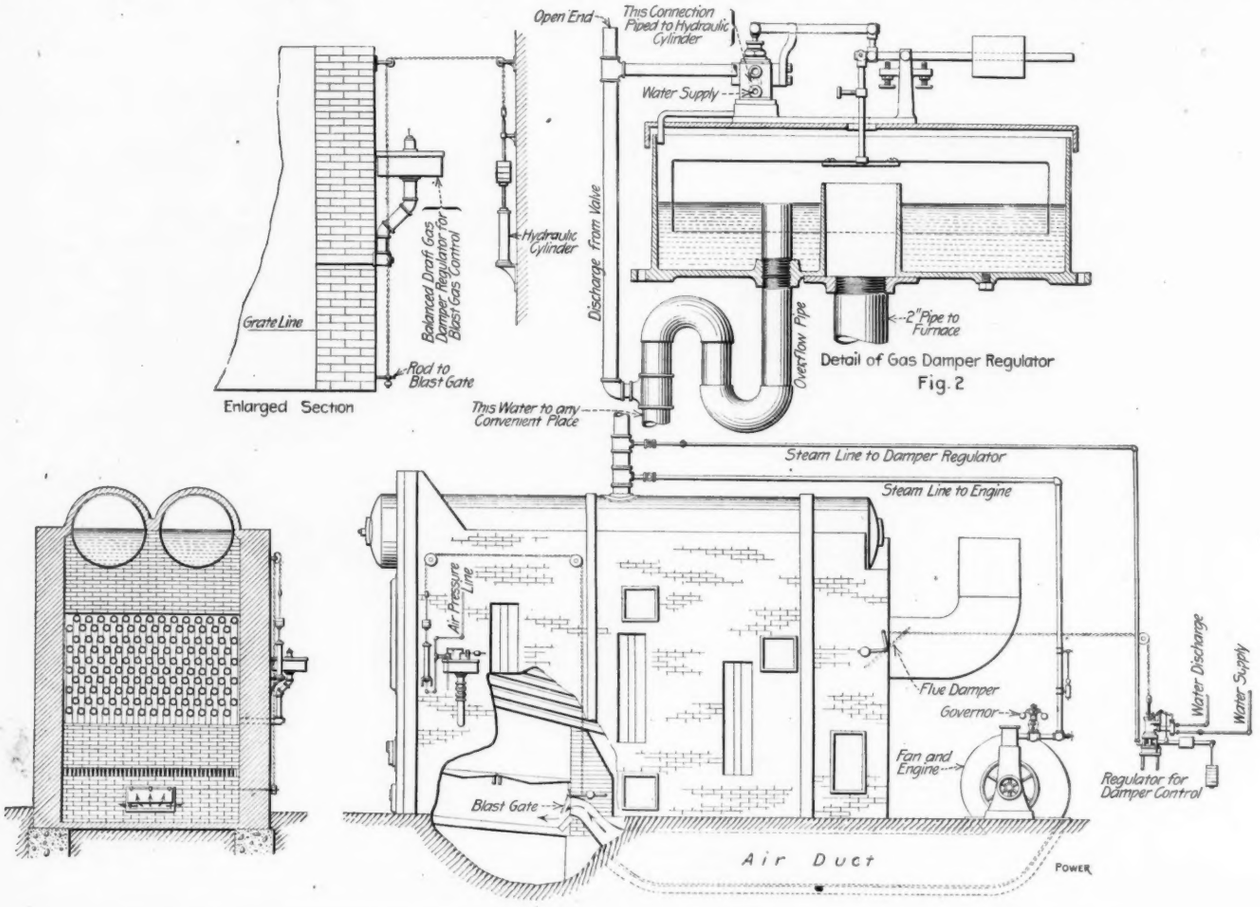
If you were to go into a boiler room and hear the term "balanced draft" used, would you know what was meant, what it accomplished, and why one would think of installing the necessary apparatus for maintaining it?

Under natural conditions, the draft in a chimney is maintained by the difference in temperature between the gases of combustion on the interior of the chimney and the temperature of the air on the exterior. As the hot gases pass to the stack, air is drawn into the partial vacuum thus formed in the furnace, and in passing through the fuel produces combustion. Why, then, should artificial means be used to produce similar results?

The ideal furnace condition is that of supplying just the amount of air necessary for complete combustion of the fuel, but natural draft will not produce this condition, and that is why artificial means are employed.

Balanced draft is a method of operating a furnace by which the exhaust gases from and the supply of air to the furnace are so automatically controlled as to bear a fixed relation to each other, so that a substantially uniform pressure is maintained in the furnace for varying rates of combustion.

Improper combustion is responsible for much of the avoidable losses of heat units in the furnace. If enough air is not supplied, a high-grade fuel must be burned, the fires must be cleaned frequently in order to reduce the resistance to the air in passing up through the grates and fuel, a low rate of combus-



FIGS. 1 AND 2. ARRANGEMENT OF BALANCED DRAFT SYSTEM AND DETAILS OF GAS DAMPER REGULATOR

tion will take place and losses of heat due to the formation of carbon-monoxide gas will occur.

If the draft is too strong, more air than is needed is supplied, and the excess air reduces the temperature of the furnace.

It is to overcome these two extremes of air supplied to a furnace that balanced draft is used, for the fundamental principle of balanced-draft control is that of maintaining in the furnace chamber, at the furnace door, a pressure which will equal that of the atmosphere. This results in a substantially higher CO_2, a higher and more even temperature in the furnace and lower flue-gas temperatures.

Another feature other than the advantage obtained in economy and efficiency is the reduction in the cost of upkeep of the boilers and boiler setting. This is because cold air drawn into the furnace during the time of firing is eliminated, thereby preventing the constant expansion and contraction due to cold air being taken into the furnace when firing under ordinary conditions; thus permitting of much longer life to both the boiler and the settings. In case the chimney of a plant is insufficient, the balanced-draft condition increases its capacity; in some cases it is claimed to be as high as 50 per cent.

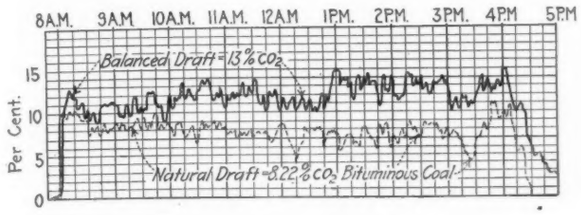


FIG. 3. COMPARISON OF FLUE GASES WITH NATURAL AND BALANCED DRAFT

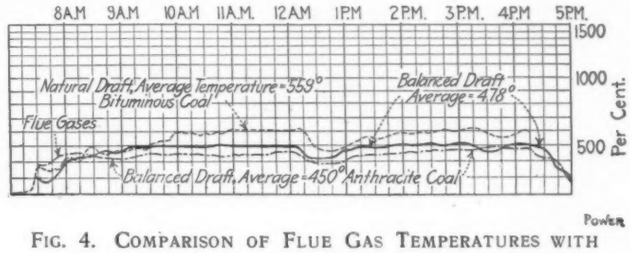


FIG. 4. COMPARISON OF FLUE GAS TEMPERATURES WITH NATURAL AND BALANCED DRAFT AT BASE OF STACK

In Fig. 1 is shown a typical application of the balanced-draft system of furnace regulation on a horizontal, water-tube boiler, as manufactured and installed by the Engineer Co., 50 Church St., New York City. By this system of regulation an individualism of the boiler unit is obtained. Each boiler is operated with respect to the particular condition existing in each unit, and each is made to do its *pro rata* share of the total output of the plant. The air supplied to each boiler is maintained with respect to the thickness of the fuel bed, so that the boiler furnace with a thin fire does not get an excess of air over the adjoining furnaces which may have thick fires.

FIG. 5. SHOWING THE BALANCED CONDITION OF THE FURNACE

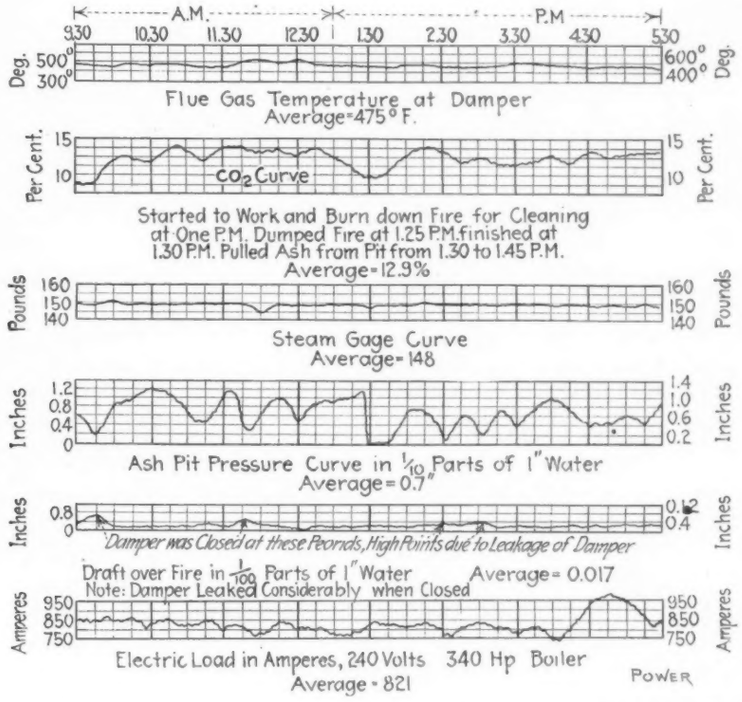

A.M.
P.M
9.30 10.30 11.30 12.30 1 1.30 2.30 3.30 4.30 5.30
Deg. 500° 300°
600° 400° Deg.
Flue Gas Temperature at Damper
Average = 475° F.
Per Cent. 15 10
CO_2 Curve
Started to Work and Burn down Fire for Cleaning at One P.M. Dumped Fire at 1.25 P.M. finished at 1.30 P.M. Pulled Ash from Pit from 1.30 to 1.45 P.M.
Average = 12.9%
Pounds 160 150 140
Steam Gage Curve
Average = 148
Inches 1.2 0.8 0.4 0
1.4 1.0 0.6 0.2
Ash Pit Pressure Curve in 1/10 Parts of 1" Water
Average = 0.7"
Inches 0.8 0
0.8 0.4
Damper was Closed at these Periods, High Points due to Leakage of Damper
Draft over Fire in 1/100 Parts of 1" Water Average = 0.017
Note: Damper Leaked Considerably when Closed
Amperes 950 850 750
Electric Load in Amperes, 240 Volts 340 Hp Boiler
Average = 821
POWER

FIG. 6. PRESSURE AND TEMPERATURE CHARTS OBTAINED WITH BALANCED DRAFT

This control also compensates exceedingly well for blow-holes in the fuel bed, which are common occurrences in some furnaces, by cutting down the air supply when such conditions exist and preventing the loss in furnace efficiency which would otherwise result.

APPARATUS USED

The apparatus necessary to produce balanced draft is a positive pressure type blower to furnish air to the boiler furnace; a special type of steam damper regulator connected to and operating the flue damper of each boiler, and a special type of balanced-draft gas damper controller connected to and operating the blast gate in the ashpit.

The engine operating the blower is regulated by a ball governor, the blower running at approximately constant speed. The blower delivers air to the main air duct at a constant pressure and volume.

GAS DAMPER

The gas damper, a sectional view of which is shown in Fig. 2, is a simple piece of mechanism and is operated by the air pressure in the furnace. It consists of an outer casing, in which an inverted pan is placed, attached to a counter-weight lever, and by means of a link and lever operates the valve controlling the water supply to the hydraulic cylinder, the plunger of which operates the blast gate. The water in the body of the gas damper is kept at a constant level by the addition of a small amount which flows into it from the water

valve. The excess water goes to waste through the overflow pipe. Connection is made to the boiler furnace by means of the central connection, which extends up into the inverted pan a suitable distance above the water level.

Operation of System

As the steam pressure reaches a predetermined pressure, the damper regulator closes the damper in the smoke flue, which increases the air pressure in the furnace, and the floating pan in the gas damper is lifted. This action cuts off the water supply to the hydraulic plunger operating the blast gate, and the weight on the plunger rod forces the plunger down and pulls up on the lever of the blast gate, which closes the air inlet of the air duct. This shuts off the supply of air to the furnace coming from the fan.

As the steam pressure drops, a reverse action takes place. The damper regulator opens the flue damper, which decreases the air pressure in the furnace, and the floating diaphragm in the gas damper lowers, causing the water valve to open. The water pressure then forces the piston of the hydraulic cylinder up and the weight on the arm of the blast gate opens the gate and admits the air from the air duct into the furnace. As these operations are taking place continuously, the steam is thus maintained at a constant pressure. All of the various controllers are always in such relation to one another that any predetermined atmospheric pressure may be maintained for all rates of combustion at the furnace door.

Temperature and CO_2 Charts

In Fig. 3 is shown a chart which gives a comparison of the flue gases with natural and balanced draft, the chart line representing the percentage of CO_2 in the flue gases.

The chart shown in Fig. 4 is a comparison of the temperature of the flue gases at the base of the stack with natural and balanced draft, the former averaging 559 deg. F., the latter 450 deg. F. As a test of the actual furnace conditions a handkerchief was suspended at the furnace door, with the boiler being worked far in excess of its rated capacity, without there being any deflection of the handkerchief in either direction. This is illustrated in Fig. 5 and shows that there is no draft, as generally understood, or current of air passing into or out of the furnace through the furnace door. It is a practical illustration of a balanced-draft condition for a boiler furnace; the view was taken in the boiler room of a large steam plant.

The charts shown in Fig. 6 were taken at the Singer Building power plant, New York City, and show the temperature of the flue gases at the damper, with an average of 475 deg. F. The CO_2 curve shows an average of 12.9 per cent. The steam record, with one or two exceptions, was practically straight, the average pressure being 148 lb. per square inch. The ashpit pressure curve shows 0.7 in., and the draft over the fire averages 0.017 in. The damper leaked when closed, which accounts for the irregularity at the points indicated by the arrows. The average electrical load in amperes was 821 and the load was carried by 340 hp. in boiler capacity.

Exploding Tank Wrecks Building

The accompanying illustrations were taken of the wrecked building of the Hine Bros. Soap Works, 4023 South Ashland Ave., Chicago, Ill., which was the result of the explosion of a rendering tank early Wednesday morning, Feb. 28.

This tank was used for rendering grease from garbage, which was treated under steam to recover the soap grease. Two men were slightly injured.

Fig. 1. Ruins of Building after Tank Exploded

The tank was 72 in. by 14 ft. and was made of 3/8-in. steel. The contents were digested under a steam pressure of 50 lb. per square inch. Fig. 1 shows a view of the wrecked building, and one of the remaining rendering tanks.

From information received from a Western correspondent, it is learned that last June another tank in this plant had been condemned by the Chicago city boiler-inspection department, and that the exploded tank was reported in bad shape and good only for about three months of service. A new tank was on the ground ready to replace the one which had been condemned.

After the explosion the safety valve of the tank was found and under test it blew at 51 lb., indicating that excess pressure was not the cause of the explosion; deterioration of the plates is the true explanation. The life of one of these tanks is said to be not more than four years, owing probably to the acidic properties of the contents.

A close examination of the tank in Fig. 1 shows that the middle sheet was riveted on the inside of the two outside end sheets. This is faulty construction,

as in this kind of work the acids which form from the garbage get in between the outer and inner sheets above the riveted joints. Had the middle sheet been riveted to the outside of the two end plates this action would have been retarded, as the acids and moisture would have collected

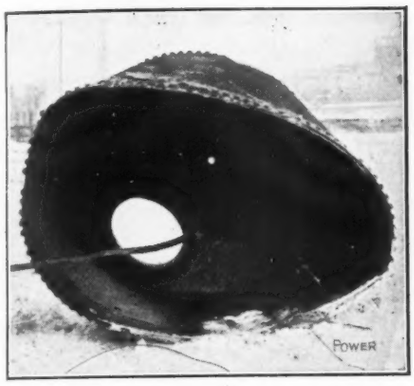


FIG. 2. TOP SHEET OF TANK SHOWING RUPTURE BELOW THE RIVETED JOINT

on the upper plate and dropped off without lodging in the joint.

In Fig. 2 is shown the top section of the tank, also the corroded condition of the second sheet, which gave way just below the riveted joint. A comparison of the outer and inner sheets can be made at the right-hand side of the illustration.

Golden-Anderson Automatic Valves

The value of an operable safety device in an emergency need hardly be dwelt upon. Many a serious boiler explosion might have been avoided by a nonreturn valve, and many an engine runaway might have been stopped before a destructive speed was reached had an emergency stop valve been a part of the equipment. The purchase of such automatic safety appliances is superior to the buying of accident insurance, as the former means money spent in preventing accidents and not in wagering that they will happen.

The valve illustrated in Fig. 1 is the Golden cushion triple-acting nonreturn valve. Besides acting as an automatic nonreturn valve, it also acts as an automatic safety stop. In addition to this, the valve may be operated by hand, by electricity from remote points and by steam. Inserted in a pipe connecting the boiler and header, it will automatically close in case the pressure in the boiler drops suddenly, because of a ruptured tube, etc. On the other hand, the valve will also close automatically if a sudden drop in pressure occurs on the delivery side of the valve.

As shown in Fig. 1, the valve is in the closed position, having been closed by hand. The spindle *A* is not attached to the valve part *B*, but simply bears on it when the valve has been closed or partly closed by hand. At other times, the spindle is clear of the part *B* and steam

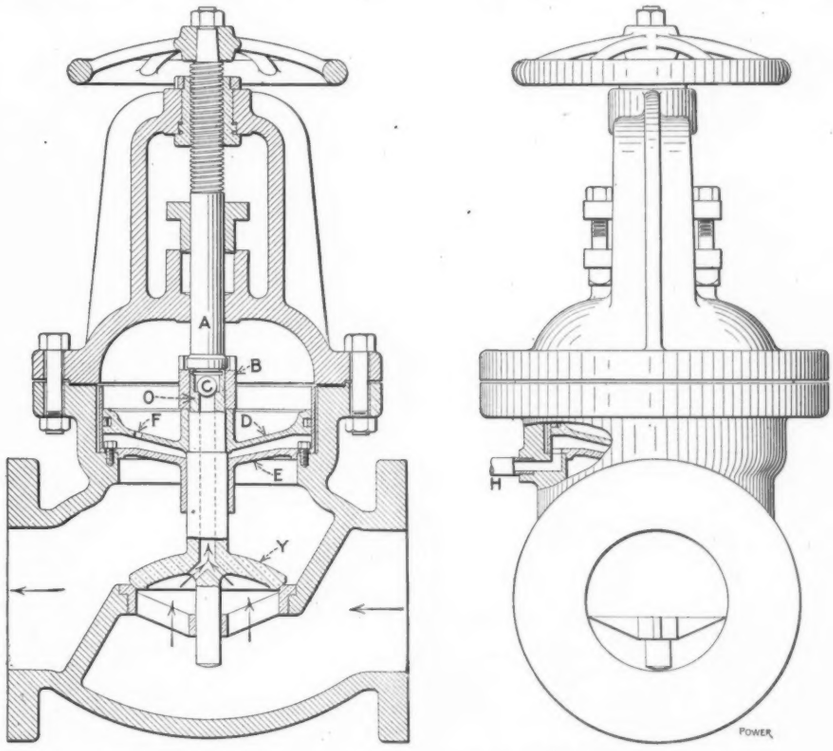


FIG. 1. GOLDEN CUSHION TRIPLE-ACTING NON-RETURN VALVE

from the inlet side of the valve is free to raise the ball *C* from its seat and fill the space above the diaphragm *D*, and also the space between *D* and *E*, through

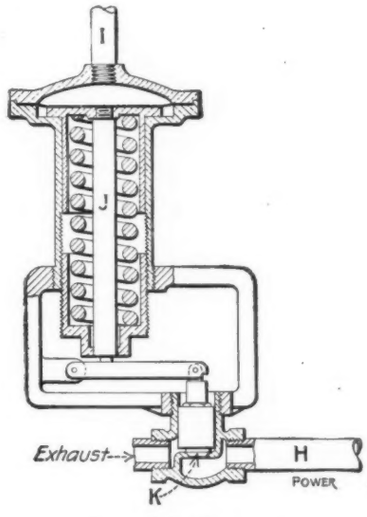


FIG. 2. PILOT VALVE

the port *F*. The diaphragm *D* is integral and moves with the main valve part *B*, while *E* is held in a fixed position by cap screws as shown. As the pressure on both sides of the diaphragm *D* is the same, the pressure of the steam acting on the under side of *Y* opens the valve and keeps it open as long as there is any flow of steam. The instant the flow ceases or reverses its direction the valve closes of its own weight.

Communicating with the space between the diaphragms by means of the pipe *H*, is the pilot valve shown in Fig. 2. The space above the pilot-valve diaphragm communicates with some point in the pipe system on the discharge side of the main valve, by means of the pipe *I*. If the pressure in the pipe *I* drops for any reason, the spring raises the rod *J*, and opens the pilot valve *K*.

As the area of the opening in the pilot valve and pipe *H* is considerably larger than the area in the port *F*, Fig. 1, in the diaphragm *D*, the opening of the pilot valve reduces the pressure in the space between the diaphragms *D* and *E*, and the full inlet pressure acting against the upper surface of *D* closes the valve and keeps it closed because the total effective pressure on *D* is greater than that on the under side of *Y*. Thus, as long as the pilot valve remains open the main valve must remain closed. By adjusting the spring on the pilot valve, the main valve can be made to close when the drop in pressure exceeds any predetermined amount.

If desired, another pilot valve *L*, Fig. 3, is connected to the pipe *H*, as at *M*, this second pilot valve being controlled by a solenoid. Then the main valve may be closed electrically from as many points as desired.

THROTTLE VALVE AND AUTOMATIC ENGINE STOP

The valve shown in Fig. 4 is especially designed as a throttle and automatic en-

gine stop valve, the principle of operation being the same as that of the valve just described. The spring *N* holds the valve part *O* up off the seat during normal conditions. Steam is admitted through the passage *P* to the chamber *Q* and through the port *R* to the chamber *S*.

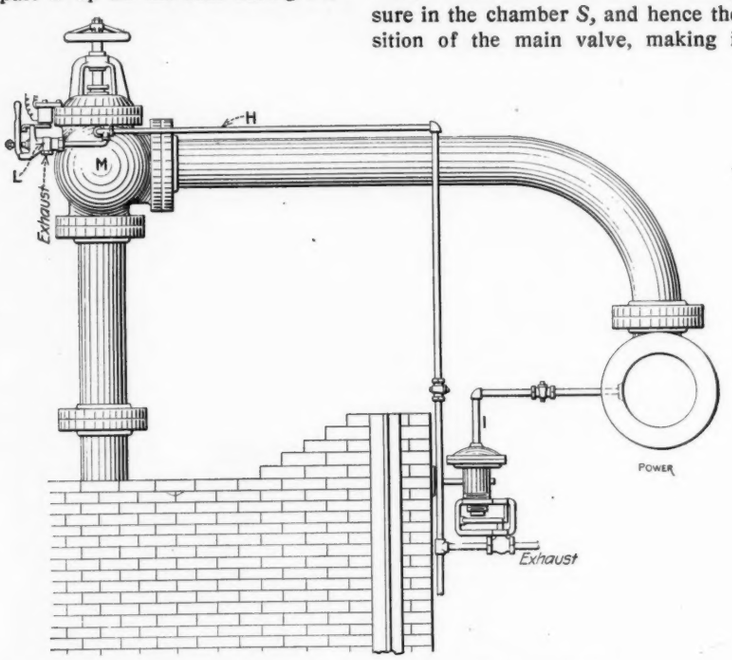


FIG. 3. ARRANGEMENT OF PILOT VALVES AND PIPING

Thus the pressure above and below the head *T* is the same.

If the pressure in *S* is suddenly reduced, the total pressure acting downward on *T* becomes greater than that acting up, and the valve is closed.

Electrically or hand-operated pilot valves connected at *U* control the pressure in the chamber *S*, and hence the position of the main valve, making it an engine stop which may be operated from as many points as desired.

When the arrangement shown in Fig. 5 is attached to the engine, the valve becomes an automatic stop operated by any overspeeding of the engine.

The small ports *V* in the main valve of Fig. 4 are for the purpose of allowing a small quantity of steam to go through when the valve is closed to keep the engine cylinder warm. This arrangement does away with the necessity of an external bypass.

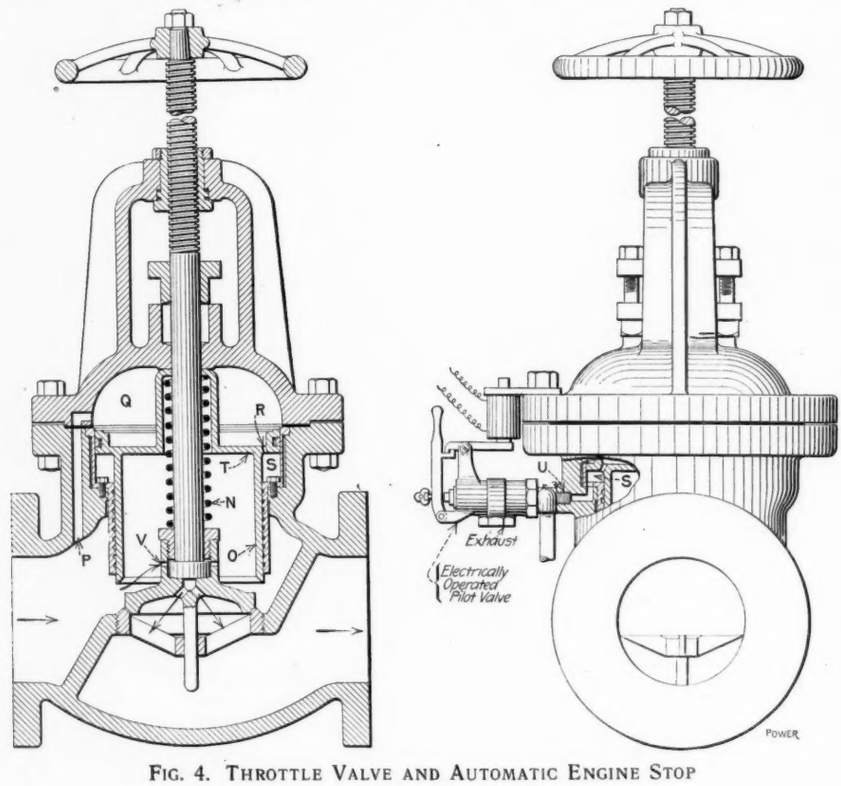


FIG. 4. THROTTLE VALVE AND AUTOMATIC ENGINE STOP

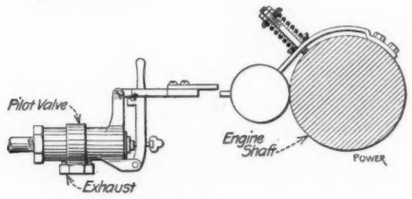


FIG. 5. PILOT VALVE OPERATED BY CENTRIFUGAL DEVICE ON ENGINE SHAFT

These valves and a full line of standard and special cocks and valves are manufactured by the Golden-Anderson Valve Specialty Co., Pittsburg, Penn.

Cotton versus Manila Rope

BY HENRY D. JACKSON

It is quite evident from reading a recent article on transmitting power by rope drive that the writer refers to manila rope, as he states that manila rope is mechanically far better suited for driving purposes than cotton.

While it can be stated that a cotton rope 2 in. in diameter will transmit approximately 90 hp. when operating at a speed of 7000 ft. per minute, it should be noted that such speeds are uncommon in this country and are impossible with manila rope. With this rope the speed is limited between 4000 and 5000 ft. because of the material effect which centrifugal force has upon the driving power and very high speeds have a decided wearing effect upon this type of rope.

The same general rule as to strain for manila rope holds equally true for cotton; that is, the maximum strain is 200 times the square of the diameter of the rope. With manila rope, however, the centrifugal force must be deducted in order to get the exact driving power, and when the rope velocity exceeds 5000 ft. per minute the driving power rapidly diminishes, owing to the effect of centrifugal force.

With cotton rope, this condition does not exist to any such extent. If properly made, cotton rope may wedge into the groove in the driving wheel because the cotton fibers are soft and do not cut one another, and this wedging permits a far higher speed before the effect of centrifugal force becomes serious.

With manila rope, this wedging action cannot take place. Although the manila fiber has great tensile strength, transversely it is small, and the fibers are tough and hard and will, if compressed, seriously injure one another. For this reason the grooves must be so designed

as to avoid any material wedging and as this wedging cannot be used, centrifugal force will naturally affect the rope to a considerable extent.

The pulley diameters which can be used with manila rope range from 36 to 50 times the diameter of the rope. With a smaller pulley, particularly at the higher speeds, the bending action of the rope around the pulley seriously injures the fibers. With cotton rope, however, the pulley diameters may be reduced to 30 times that of the rope without any difficulty, and under certain conditions to even less.

Rolling is particularly recommended for manila rope as this tends to increase its life by maintaining it in its original cylindrical form and preventing it from assuming a wedge shape, which will ruin it in a short time. Rolling is to be deprecated on cotton rope, however, but the wedge shape is desired because it increases the tendency of a rope to wedge into place, thus increasing the driving capacity.

The number of strands used with manila rope varies from three to six, depending upon the size of the rope and the condition of the drive. The four- and six-strand ropes are more expensive in first cost and also in working, but owing to the fact that the ropes do not meet in the center, a core is required which takes up room and actually does nothing in the driving; it is also a nuisance when splicing becomes necessary.

For cotton rope three strands are sufficient; the rope is then easier to make and easier to splice, both of which items are of considerable importance.

There seems to be a lack of interest in this country regarding cotton rope. Rope manufacturers here claim that manila rope is superior to cotton, and judging from cotton ropes that have been put on the market, this is true; this, however, may be due solely to lack of experience in the making of cotton rope.

It is hard to believe that cotton rope is not equal to manila, particularly when one knows that the former is the only satisfactory medium of transmitting power to the spinning-mule motions, not only in this country but abroad. Leather belting, manila rope, etc., have failed; cotton rope has been a success from the start. The average life of manila rope, according to the manufacturers, is from 6 to 12 years, but many rope drives cut out in a much shorter time.

Another claim is that manila rope will transmit more power at the same speed. That may be true of the cotton rope manufactured in this country, but the experience of the English, French and German manufacturers proves the contrary. Many drives abroad have been running from 16 to 20 years without failure, and there are well authenticated instances of drives that have been running from 23 to 30 years, and are still running; these, however, are all of the English or single-warp system.

As for the transmitting power of cotton rope, the writer will cite two instances where this rope replaced the manila rope. In the first case, six 2-in. cotton ropes replaced eight 2-in. manila ropes, and did equal work and proved far more satisfactory than the original drives. In another, eight 1¼-in. ropes replaced 10 of manila, with a corresponding improvement in life and driving.

So long as it is impossible to get a satisfactory cotton rope in this country, users should not hesitate to install a manila rope drive in many places in preference to belts or electrical motor; all kinds of drives have their places, and the rope is among the best.

An Engine Room Experience

By Alonzo G. Collins

Many years ago I was in charge of an old-fashioned slide-valve engine which furnished the power for a wood-working establishment. Machinery had been added from time to time, and the engine had been speeded up to 110 revolutions per minute to handle the increased load until it kept Hans, the fireman, busy keeping up steam in the two boilers with the fuel used, which was the shavings and offal from the factory.

The engine was not built for any such speed; in fact, when I took charge, it was running at about 70 revolutions per minute and with the increased speed it had to be watched very closely to prevent going to pieces under the strain. The part giving the most trouble was the piston, which was fitted with what was then considered the last word in piston packing, namely, two cast-iron rings, one inside the other, split on diametrically opposite sides. These were set out by half-elliptical springs, adjusted by setscrews, which in turn were secured by locknuts. It was good packing for the slow-moving pistons ordinarily used at that time, but at the speed at which our engine was running, the setscrews frequently jarred loose, or the rings wore down, so as to require adjusting every week.

We were in the habit of shutting down at three o'clock on Saturday afternoons, and advantage was always taken of this opportunity, while the cylinder was hot, to do the adjusting, centering the piston carefully to the bore of the cylinder and setting the locknuts securely; and as that part of the engine room was rather dark, I always had Hans hold a lamp and assist in other ways as might be needed. Things went on this way for about a year, and as this was our regular Saturday afternoon job, it would be inferred that Hans would have learned something in that time.

One day the management got the idea that my job was too easy, and they made the proposition that I do the firing as well as look after the engine. Upon demurring I was told that Hans was willing to attend to both, and that my time would be up the following Saturday afternoon.

Accordingly, the following Saturday afternoon, instead of making the usual adjustments on the piston, I got into my street clothes, received my money and left for home.

It happened that times were hard, and beyond an occasional job tinkering around an old engine, or a few days in a machine shop, I had nothing to do. Upon meeting my old boss on the street one day, he inquired if I was doing anything and, receiving a negative answer, said that he was going to put in a small engine to run the machinery in the shed down by the river, and take out the old wire-rope transmission, and I might have the job of installing it at the same wages I had been getting as engineer.

I agreed to this, and the next morning went to work. As my duties took me to the old engine room frequently, I had plenty of opportunity to see how the engineer-fireman was getting along, and from the racket the engine was making, I concluded he was not doing very well.

This went on until about 11 o'clock one Saturday forenoon, the foreman came to me and said, "The boss wants you to go up to the engine room and see what is the matter with that engine; this is the third time this morning we have shut down for want of steam, and he thinks there is something wrong." Upon my arrival at the engine room, Hans put on his coat and left, and a couple of young men from the factory were put to firing. We managed to hold through the forenoon; but I told the manager that he might as well send the hands home for the rest of the day, as it would take all the rest of the day to get the engine in order. This was done, but instead of getting things fixed for a start Monday morning, they had to get a new piston, and did not get started until the latter end of the week.

The six springs, six setscrews and the twelve locknuts were all in a heap in the bottom of the piston, where they had rattled around until the hexagon nuts had lost all semblance of shape and were just plain rings. A hole had been worn through the piston head and also through the follower, but fortunately it was not large enough to let the setscrews through, which was all that prevented a broken cylinder head or worse.

Hans was called in when I had the junk laid out on the floor, and was asked why he had let things get in such shape; his answer was as follows: "Why, I couldn't see in there," and he had been "seeing in there" every Saturday for about a year, and still had no idea why it was done. The result was that when they started the repaired engine again, I was the one who opened the throttle.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

The Oil Power Yacht "Mairi"

The accompanying engravings illustrate the salient features of the power plant of an oil-driven yacht recently built by the widely known Beardmore shipyard at Dalmuir, Scotland, for the Marquis of Graham, who, by the way, is president of the British Institution of Marine Engineers.

A perspective view of the engine is given in Fig. 1 and an elevation and detail drawings are reproduced in Figs. 2 to 5. The location of the engine in the ship is shown in Fig. 3. The engine is the nearest approach to the Diesel type that has yet been attempted without resorting to high compression within the cylinder. The compression is limited to 150 lb. per square inch, and the explosion pressure is never greater than 300 lb. per square inch with the lighter oils, such as kerosene, and is generally in the neighborhood of 200 lb. when using heavy oils, such as Texas or Solar. As a consequence, a heated combustion chamber *G*, Fig. 4, is provided to effect the starting of the engine. This combustion chamber is heated with a blow-lamp, a process occupying about 5 minutes. But, as in all medium-pressure oil engines, the heat of the explosion and compression when the engine is well under way is sufficient to keep the combustion chamber hot enough to make the engine self-igniting. This is practically the only difference from the ordinary Diesel system of working.

Since the maximum pressure in the cylinder is so low, it is found sufficient to use air at a pressure of 400 to 450 lb. per square inch to inject the fuel, which is done in exactly the same way as in the Diesel engine. The engine works on the two-stroke cycle, the charge of air being drawn into the crank case by the up-stroke of the piston and compressed on the down-stroke. It is admitted to the cylinder when the piston uncovers the port *I*, shown in the left-hand side of the cylinder in Fig. 4.

In the engine here illustrated, there are four working cylinders 9 in. in diameter and the stroke is 13 in.; the two-stage compressor (Fig. 5) is driven by a fifth crank placed forward—to the right in Figs. 1 and 2, in which the small pumping set and thrust-block are shown on the left. The compressor crank is so placed that the primary balance of the engine is correct, and this was proved by the absence of vibration when the engine was speeded up to 400 r.p.m.; the designed speed is 350 r.p.m.

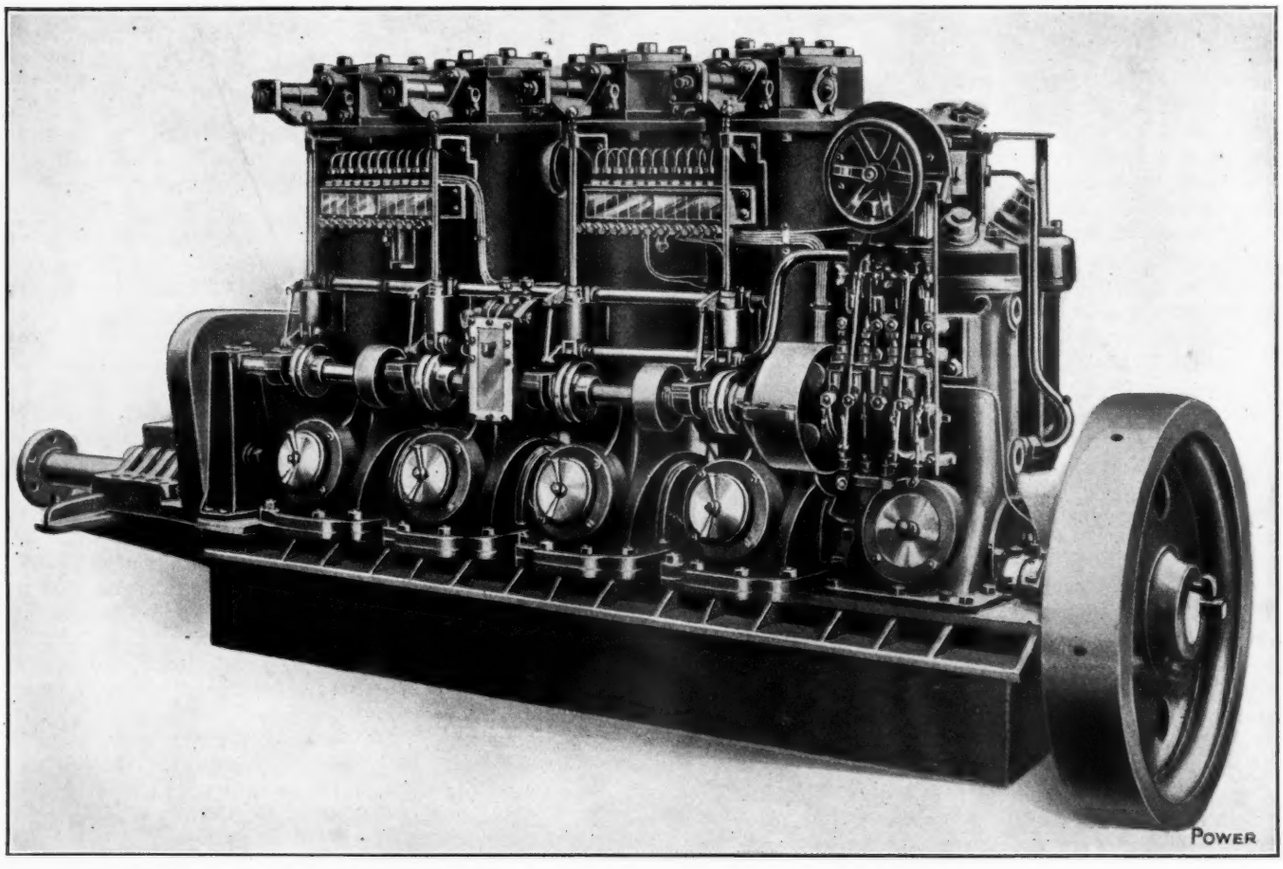


FIG. 1. MEDIUM-PRESSURE REVERSING OIL ENGINE OF THE YACHT "MAIRI"

REVERSING MECHANISM

The starting and reversing gear and the oil and air controls are all grouped on the forward end of the engine, so that everything necessary for working the engine is at the engineer's hand. The maneuvering of the engine is done by

means of one handwheel with a pointer moving over a dial (*E* in Fig. 2). In the middle position the engine is stopped; to go ahead or astern the wheel is simply moved to the right or to the left.

There are four fuel pumps, one to each working cylinder, driven by two eccentrics, and the discharge from these is regulated by the handwheel acting on the suction valves, so that any speed from 0 to full ahead and from 0 to full astern may be obtained by the same movement that admits the fuel injection air to the inlet valves and the starting air to the working cylinders. Each fuel-oil pump is also fitted with a separate adjustment, so that any one cylinder can be given more oil independently of the handwheel control. The pump plungers have a device for hand pumping in order to force the fuel oil up to the inlet valve before starting, so that on the first revolution of the engine the oil is sure to be injected into the cylinder, and thereby the minimum amount of starting air is required. The fuel oil is also under the control of the governor, which can cut off the supply, no matter what the position of the handwheel may be.

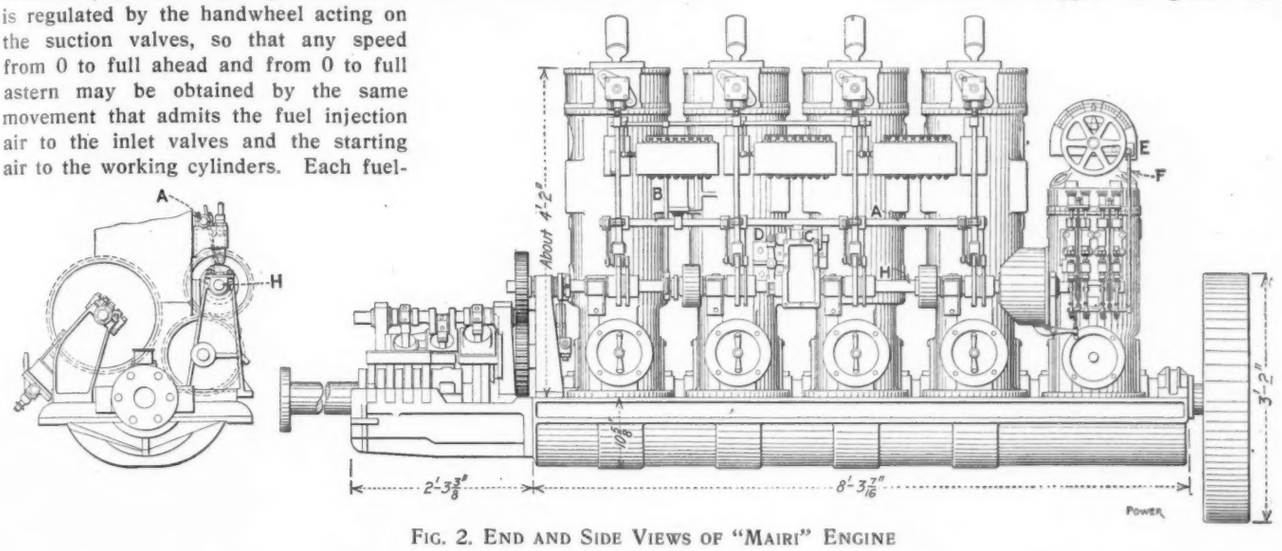


FIG. 2. END AND SIDE VIEWS OF "MAIRI" ENGINE

Two cams have been adopted for reversing the injection valve, on account of the greater flexibility obtained in manufacture; and these are operated by the camshaft *H*, Figs. 2 and 4. Above the cams, and on the end of the push rod operating the valve, are two rollers mounted eccentrically on a spindle, as shown in Figs. 2 and 4. The spindle is connected to a layshaft *A* (Figs. 2 and 4) running along the engine, and this layshaft is rocked by a small air cylinder *B*, Fig. 2, so that either one or the other roller is dropped into gear. This cylinder is shown between the two aft working cylinders. The arrangement of levers between the camshaft and layshaft is shown in Figs. 2 and 4.

The air-starting gear consists of a rotating plate with one hole in it, and this

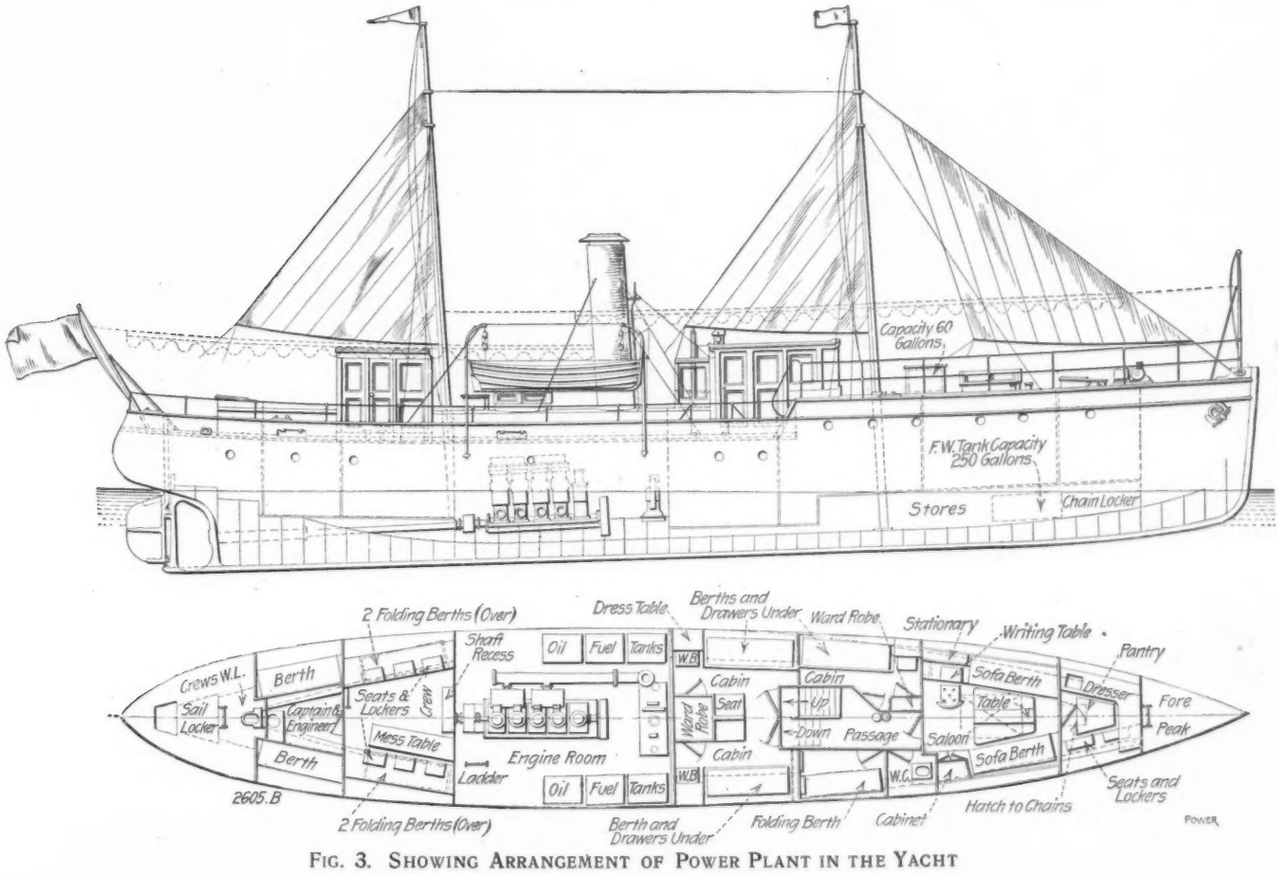


FIG. 3. SHOWING ARRANGEMENT OF POWER PLANT IN THE YACHT

passes over a faceplate containing four apertures, one for each cylinder, equally spaced. The rotating plate is driven from the camshaft by means of spiral gears and is consequently at right angles to the camshaft. To reverse, it is only necessary to turn the rotating plate through a certain angle, and this is done by sliding one of the spiral gears by means of another air cylinder. This gear is located between the two center cylinders, at *C* in Fig. 2. The air cylinder is located just above the camshafts, and slides the gearwheel on the camshaft by means of a simple lever arrangement *D*.

The air cylinders for reversing the injection valve and air-starting arrangement are fitted with pistons having piston rods of such diameter that the area on the back of the piston is twice the area on the front. The lesser area is permanently connected to the air-storage tanks, so that the pressure pushes these pistons hard back in the cylinders. The gear is then in the ahead position. When pressure is admitted to the large area, it overcomes the constant pressure on the small area and the gear is pushed into the astern position. To bring the gear back into the ahead position, it is only necessary to open the large area to exhaust, when the constant pressure on the small area instantly asserts itself. These operations are accomplished by the handwheel *E* opening and closing two small air valves by means of cams keyed on the spindle. Two other cams are similarly used for controlling the starting and injection air, and a special one is used for acting on the suction of the fuel pumps, so as to give all the gradations from stop to full speed. These latter three cams have double raised portions on them, so that they open the valves no matter in which direction the handwheel may be turned. The cam for opening the starting air valve is mounted on a spindle which passes through the center of the handwheel, and a knob is fitted to the spindle. If this knob is pushed in, the cam is moved along with it against a spring, and the starting air is shut off.

The method of operating the gear is as follows: The handwheel is moved over, thus dropping the oil pumps into gear and turning on the injection and starting air. As soon as the engine is under way, the knob is pressed in, cutting off the starting air; it is held in by means of a little plunger operated by a spring. To stop, the handwheel is brought back to the center, and when in this position the air-starting cam springs back into gear, so that it is then able to admit starting air, no matter in which direction the handwheel be turned. The rod *F* is pulled up by means of the handwheel *E*, in order to shut off the oil. It is pushed back by a spring when the handwheel is returned to its original position.

At the after end of the engine, close to the thrust block, a small pumping set is arranged. This consists of a circulating and bilge pump and a small air compressor for keeping up the supply for maneuvering and whistle blowing. There is also provision for taking air from the main engine compressor for charging up the reservoirs. The engine is equipped with a very complete system of forced sight-feed lubrication, and the quantity to any pin bearing or cylinder is under individual control; an arrangement for flooding all the parts before starting up is also provided.

The engine has been designed especially with a view to continuous running, and all the parts are made easily accessible. To take off the cylinder cover it is only necessary to undo two small pipes and the stud nuts, and it can then be lifted away. The main bearings and crankpin bushes can also be removed in a few minutes, and all adjustments can be made while the engine is running.

Two large air tanks are installed for providing maneuvering air, and contain sufficient air for about 40 starts. In entering and leaving the dock at Liverpool recently, as many as 30 stops and starts were necessary, and these severe conditions were easily met, the engine never once refusing to reverse. It was also noticed that the engine was slightly quicker than the Diesel engine in starting, and that a drop of about 5 lb. in one air tank was sufficient to give a start.

The fuel-oil consumption is 56 pints of crude Texas oil of 0.875 specific gravity per hour, about the same as in Diesel engines of the same power (130 hp.). The indicator diagram, Fig. 6, shows the low maximum pressure obtained.

An auxiliary oil engine of 7 hp. is carried, and can be coupled direct to the dynamo, air compressor, and fire and bilge pump. The dynamo provides current for working the windlass, as well as for the electric-light installation and electric radiators. Circulating and bilge pumps are also driven off the shaft.

The motor yacht here illustrated, named "Mairi," is the largest full-powered crude-oil motor yacht so far constructed in Great Britain. The hull is 80 ft. long between perpendiculars, 85 ft. over all, 13 ft. 6 in. beam, and 8 ft. 1 in. molded depth amidships. The "Mairi" has been designed for making extended cruises, and is quite capable of going to Norway or the Mediterranean without involving undue endurance on the part of her crew.

On trial the yacht obtained a speed of 10.3 knots as a mean of six consecutive runs on the measured mile, and accomplished a very satisfactory 24-hour non-stop run at full speed in the Firth of Clyde, the engines developing 130 brake horsepower when running at normal speed. At this speed the fuel-oil tanks have sufficient capacity to give a radius of 1000 sea miles.

We are indebted for the foregoing particulars and the accompanying illustrations to *Engineering*, of London.

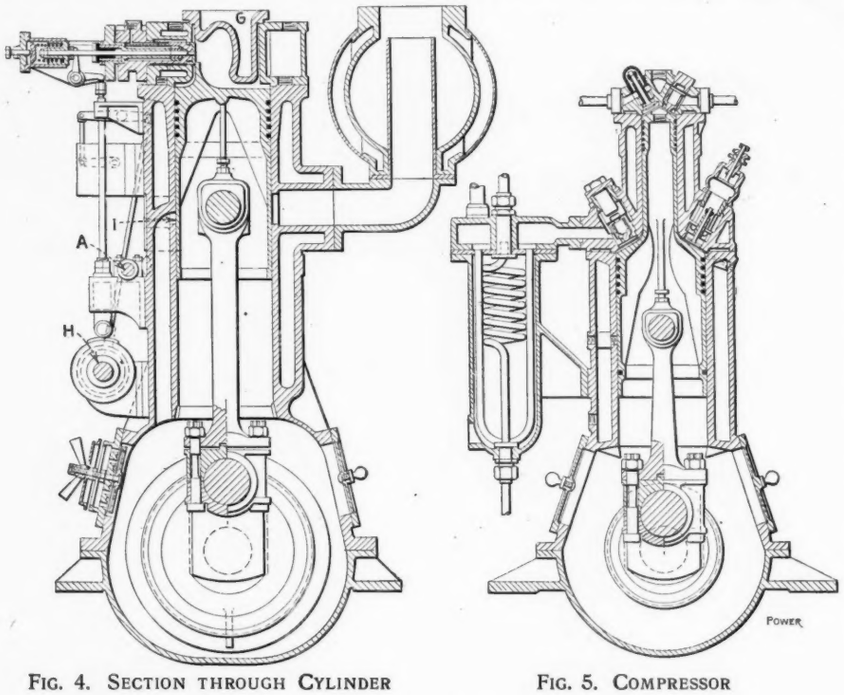


FIG. 4. SECTION THROUGH CYLINDER

FIG. 5. COMPRESSOR

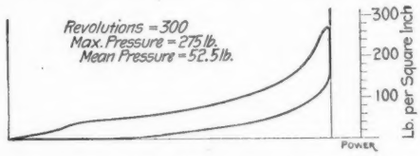


FIG. 6. A TYPICAL DIAGRAM

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Catechism of Electricity

The Open Flame-arc Lamp

1233. *Are there any other types of carbon arc lamp?*

Yes; there are two other types, closely related to each other and both known as "flame-arc" lamps.

1234. *What is the difference between them?*

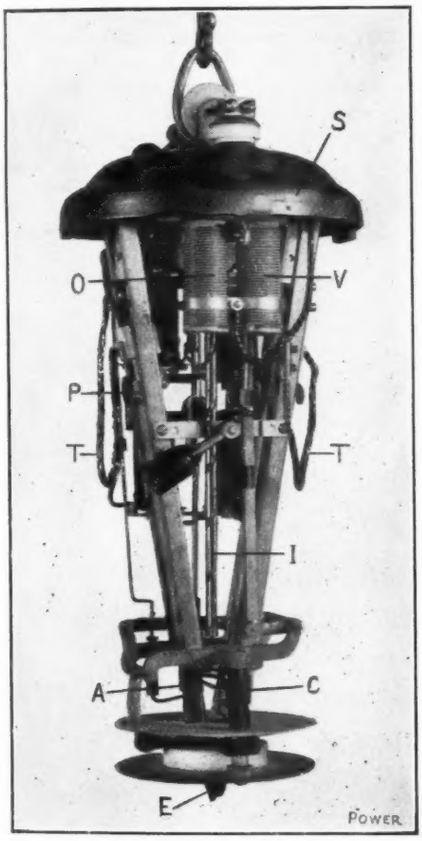


Fig. 408. Open Flame-arc Lamp

One is of the open type and the other inclosed; this apparently small difference, however, causes a great difference in the arrangement of the carbons and the design of the mechanism which "feeds" the carbons as they are consumed. In the open type both carbons project downward, with their active ends close together and their mount ends separated, and both are fed downward. The carbons of the inclosed type are arranged end to end, exactly as in the ordinary arc lamp.

1235. *Illustrate and describe an open flame-arc lamp.*

Figs. 408, 409 and 410 show interior views taken at different points around such a lamp. Upon close inspection of Fig. 408 it will be evident that the carbons *A* and *C* both extend downward at opposite angles with the vertical center line of the lamp, the lower ends nearly touching at *E* when the lamp is "dead." The arc is found between the facing portions of the carbon tips and to prevent it from creeping up the sides of the carbon rods a magnetic field is provided by magnet poles located at *M* and *N*, Fig. 409.

1236. *How do the magnet poles prevent the arc from creeping up the carbons?*

The field produced between the poles "blows" the electric arc downward by magnetic repulsion. This causes the arc to curve downward and expand into a sort of flame, as represented in Fig. 411. It is from this that the lamp gets its name.

1237. *What is the function of the part shown at* D, *Fig.* 410?

This is a chamber of highly refractory material which surrounds the ends of

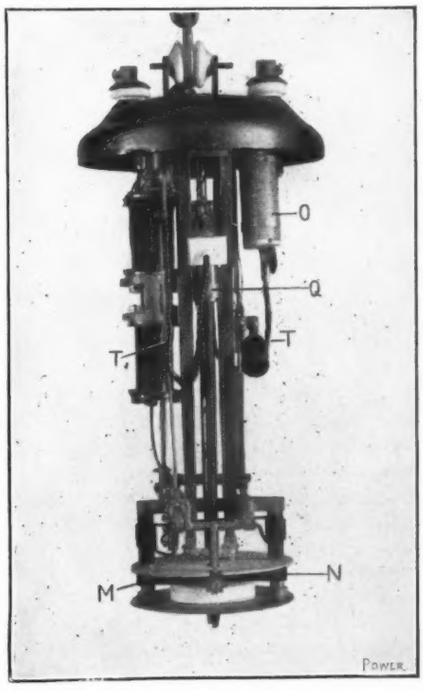


Fig. 409. Side View of Fig. 408

the carbons and shields them from "washing" of the air currents within the globe. This part of the lamp is called the "economizer" and is necessary on account of the rapidity with which the carbons are consumed.

1238. *What is the type of feeding mechanism used?*

It is of the differential solenoid type and is shunt starting; that is, when there is no current through the lamp the carbons are apart. When the current is switched on, the shunt coils *F* and *G*, Fig. 410, are first actuated, pulling the

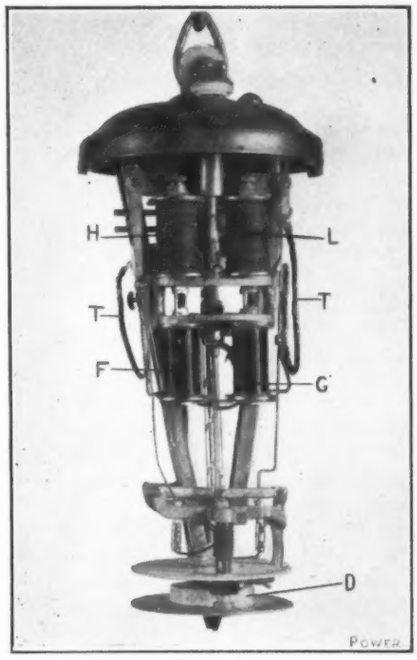


Fig. 410. Opposite View from Fig. 408

carbons into contact and thereby establishing a circuit through the series coils *H* and *L* and the carbons. The series windings then pull the carbons upward, separating the ends and forming an arc, which is thereafter differentially regulated by the shunt and series coils as described in the previous section of the Catechism.

As the carbons burn shorter they are fed downward by means of the central spiral rod *I* down which travels a crossarm that carries the carbon holders *P* and *Q*. The rod *I* is nickeled to insure smooth traveling for the crossarm and extends up into the casting *S* where a speed-reducing escapement is located.

1239. *What are the objects at* T, *which resemble strings of beads?*

These are the leads connecting the carbon holders to the circuit; they are insulated by glass beads which are threaded on them.

1240. *What is the purpose of the coils* O *and* V, *Fig.* 408?

They are voltage-reducing and steadying resistances used in series with the lamp when one lamp is connected to a 110-volt direct-current circuit. By using a reactance in place of the resistance, the lamp can be operated singly on 110-volt alternating-current circuits.

1241. *What kind of carbons are used in this lamp?*

Cored carbons containing metallic salts

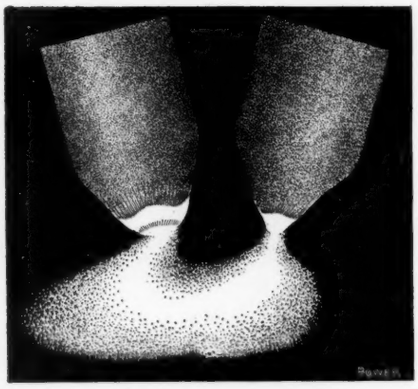


FIG. 411. A "FLAME" ARC

and a metallic strip running throughout the length.

1242. *How long will the carbons burn?*

One set will burn about 17 hours with a current of 12 amperes.

1243. *What advantages have the flame-arc lamp over the ordinary arc lamp?*

It is much more efficient and the light is much more powerful than can be obtained from the ordinary carbons.

An Opportunity for a Real Central Station Man

BY E. M. GRAHAM

While trying to work up interest in a lighting plant for a small town I was frequently met with questions and uncomplimentary comments relating to a plant in a neighboring town; it did not pay; the service was worse than none at all, and so on. Not having been to the town mentioned I was unable to discuss the plant intelligently, but a little later an opportunity was offered to go over there and investigate, which I gladly accepted.

The town was small, the population being less than 1000 people, but they were trying to make the plant pay a manager $100 a month, a bookkeeper $25 a month and two engineers $65 a month each. The plant was located on a stream about a mile from the railroad and used water-power eight months of the year, but it so happened that the four months when steam had to be used were the months when the lighting load was the heaviest. Power was being furnished for a flour mill about half a mile distant and the engine was intended to run the mill and light the town at the same time, but it would not do it. It was rated at 100 hp. and was of the high-speed flat-valve type. The engineer in charge said the engine would not run right with the steam pressure above 80 lb. When the lighting load came on it was necessary to shut the mill down, although the lights did not require over 40 hp. at the peak and about 15 hp. for two-thirds of the night.

Thirty-two candlepower carbon-filament lamps are used on the streets and permitted to burn continuously. A system of flat rates is in use which would require a person lighting a seven-room house to pay about $4.50 per month regardless of the current consumed, with the natural result that many people refuse to use the service.

There is no means of weighing the coal, hence it is impossible to tell what proportion of the fuel should be charged to running the mill. The engineer thought that the engine valve leaked but had never had an indicator on the engine to determine its condition.

The owners denied losing money on the lighting business; if they are not losing money they certainly could make a handsome profit if they would install an engine of a size to handle the lighting load economically, provide means for shutting off the street lamps when not needed, adopt rates that would attract business rather than drive it away and cut down the expenditure for salaries to a point appropriate to the size of the plant. If the manager so manages things that he has no time to keep the books a different management would seem to be advisable.

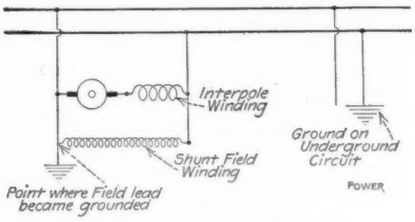
LETTERS

Peculiar Cause of Racing

Some time ago I had occasion to clear up what proved to be a comparatively simple trouble case, but it was extremely puzzling at the time because of the manner in which it made itself manifest. The apparatus involved was a 5-hp. 220-volt shunt-wound interpole motor, installed with a Cutler-Hammer drum-type controller which varied resistances in both the armature and the field circuit. The resistors were contained in a separate case.

After this equipment had been installed and connected up it was found that the motor speeded up far beyond the maximum rated speed of 1600 r.p.m. and sparked violently with the controller set so as to put about half of the external resistance in the field circuit. My first conclusion was that the man who made the connections between the controller and the resistor case had got some of the leads between the several controller contact buttons and the various field resistor taps confused. On second thought, however, I realized that this would only cause the motor to attain its maximum rated speed, assuming that the middle contact button was connected to the last field resistor tap. The indications pointed to a complete loss of field excitation.

In order to eliminate all questions of fault in the controller, I disconnected the two field terminals of the motor and connected them to a small water rheostat. On starting up the motor it operated precisely as before, running away after reaching a certain speed. On applying a piece of iron to the undersides of the pole tips, my theory as to a complete loss of field was verified. Upon removing the journal bracket at the pulley end of the motor to look for what I thought was an intermittent loose connection between two of the field-magnet coils, it was found that in rotating the end bracket for inverted hanging of the motor, the man doing the work had managed to squeeze one of the field leads between a coil and a part of the end bracket, causing a partial ground, the resistance of which, when the vibration and stresses on the bracket reached a certain value (depending on the speed), became low enough to shunt out the



GROUND IN FIELD LEAD

higher resistance of the field winding, but not sufficiently low to cause a dead short-circuit of the motor. The motor was supplied from a two-wire circuit one side of which was grounded by a fault on an underground cable connected to the same line and the field winding was shunted out by two grounds, as shown by the accompanying diagram.

After insulating the break in the field lead, reassembling and connecting up, the motor operated all right.

CHARLES E. MEAD.

Jermyn, Penn.

Rewinding Induction Motors

Following the advice in R. H. Fenkhausen's article in the Jan. 30 issue on "Rewinding an Induction Motor Stator," as to the use of oiled linen or cambric in the slots next to the coils, would be likely to cause an amateur winder a great deal of trouble.

I would suggest that a thinner amount of first insulation be put on the coils in order that the correct thickness of leatheroid or fish paper can be used for the cell proper. If the voltage would permit, it would probably be better to use two thicknesses of thin leatheroid with the oiled linen between, rather than put the line next to the coil.

L. EARLE BROWNE.

Roundup, Mont.

Refrigeration Department

Principles and operation of ice-making and refrigerating plant and machinery

Siphoning and Boiling Over

BY WALTER C. EDGE

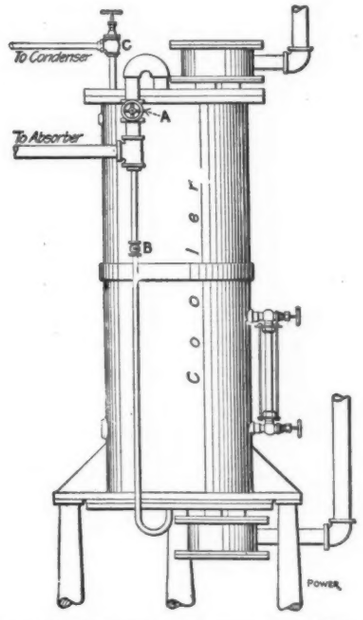
When a steam boiler is worked too hard, it will foam, and sometimes considerable water will go over with the steam. It is just so with the generator of an absorption system. If it is pushed too hard it will boil over, and considerable moisture will go over with the gas into the condenser. This eventually reaches the cooler or cooling coils, where it stays until taken out by purging. This rarely ever happens with a horizontal generator or still, but it is not uncommon with the vertical type.

In the writer's opinion boiling over occurs in the majority of cases when the condenser is empty, all of the anhydrous ammonia having been sent throughout the system. This gives the cooling water in the condenser very little to do, and the velocity of the incoming gas is greatly increased, thus exerting the same pulling or siphoning effect on the generator as a heavy overload would on a steam boiler.

If the machine is worked hard, it is advisable to carry more anhydrous ammonia in the system than is the usual custom so as to be able to hold considerable liquid ammonia in the condenser at these times. Of course, a little moisture will go over with the gas at all times, but this should go no further than the rectifying tank. The water in the tank should be kept at 110 to 120 deg., and if kept at this temperature the moisture will be trapped and sent back to the analyzer. Should the water become too hot, the moisture will go through with the gas and lie in the cooler or cooling coils until taken out by purging. Again, should the water be too cold, the rectifier will trap not only the moisture but considerable gas; and in a short time the aqua solution will become so strong that it will not do its work properly. This can be explained more clearly by describing the actual operation as follows:

The weak liquor leaves the generator very hot, its strength being about 18 per cent. It is cooled considerably by passing through the exchanger, and in some cases in the weak-liquor cooler. Arriving at the absorber, it is sprayed from the top and absorbs about 10 per cent. of gas, making its strength 28 per cent. It falls to the bottom of the absorber and is pumped back through the exchanger, equalizing temperatures with the outgoing weak liquor. After passing through the exchanger, it goes to the analyzer, where it falls over hot plates, as in an open heater, to the generator or still below. When it reaches the analyzer it is very hot, and gives off very nearly all the gas it has absorbed, coming back to a strength of 18 per cent. when it reaches the generator.

If the rectifying tank is too cold and sends back much of the gas just liberated, it is easy to see that the strength of the weak liquor in the generator is going to rise, and for every 1 per cent. of strength



THE COOLER OF AN ABSORPTION PLANT

added to the weak liquor in the generator, 1 per cent. less gas will be absorbed from the cooler or cooling coils when it reaches the absorber. This will show on the gages, the pressure going up on the generator absorber and cooler. It is at this time that the machine will siphon, or, in other words, weak liquor will go over to the cooler if care is not exercised. If the expansion valve is shut off the pressure in the cooler will be greatly reduced and it is liable to siphon from the absorber. The writer knows of one particular case where this difficulty was overcome by putting a check valve between the cooler and the absorber. It can be prevented, however, by keeping plenty of cooling water on the absorber, and not shutting the expansion valve entirely.

Another valve of great importance is the one in the steam line to the heating coil in the generator. The setting of this valve should be studied carefully as it is important to know the proper pressure to carry on the steam coil for best results. If the pressure is too low the weak liquor becomes strong, giving the same trouble just gone over. If the pressure is too high, the head pressure on the generator becomes excessive, and there is a great chance of its boiling over.

It is, of course, best to keep the cooler as free from moisture as possible, and the only way to get it out is to purge the cooler. This may be done in three ways: The usual one is to close the gas valve *A* in the illustration and open the purge valve *B*. This way of purging necessitates stopping the cooling process. A method possibly new to some engineers is to have both of these valves open at the same time, allowing the cooler to do work while being purged. The disadvantage in this method is that it takes a long while to do it, and meanwhile very little useful work is done. If it is necessary to purge the machine in a hurry, the small valve *C* connecting the condenser to the cooler may be opened, thus putting the condenser pressure on the cooler and forcing out the moisture. It is not advisable to purge in this way as it throws the cooler back too much.

It is a good thing to open the weak-liquor valve a little more than usual when purging the cooler, so as to send enough weak liquor over to absorb all the gas, as trouble is sometimes caused by the ammonia pump becoming gas-bound. It is a very good idea to have a valve on both the suction and discharge line to the pump. Should the pump get gas-bound it can be relieved by opening one of these valves and discharging the gas into a bucket of water.

LETTERS

Piston Rod Packing

Several years ago I had the same trouble with ammonia pump piston-rod packing as described by H. G. Gibson in the Feb. 20 issue. The rods had been badly scored by a former engineer, who used hard hemp packing and allowed it to get dry and burnt. I tried several remedies, but the one giving the best results was to use alternately a ring of soft flax and a ring of composition packing. The combination kept the rods tight and well lubricated. After putting in

new rods, I tried a wedge ammonia packing, but obtained the best results by using a header ring of the composition packing at each end of the gland with the wedge packing in the center.

L. M. JOHNSON.

Glenfield, Penn.

I took charge of an absorption plant and soon had trouble with the piston-rod packing. It had become misplaced and what liquor passed the spool was forced out. After cleaning the stuffing-box I inserted rings of packing: a solid one first, then diagonally split rings and a solid one again next to the spool. This was repeated on the outer end of the spool, making four solid rings and all of the rest split rings. A little graphite on the rod will prevent any trouble.

My machine runs 24 hr. a day, four months in the year. I have been here for three years and have only packed the pump three times. The present packing has been in for over a year and is still all right. The pump is a 7 and 2½ by 10-in. I do not draw the packing up too tight to begin with, and after one day's run I loosen it up a little.

ARDAN MITCHELL.

Brooklyn, N. Y.

Troubles in Refrigerating Plant

On a 50-ton ice machine the crankpin suddenly became hot, although the oil cup was feeding regularly. The engineer in charge was not a believer in sand for hot boxes before he knew the cause of the heating. Another machine was started and the machine giving trouble was stopped so that the head of the ammonia compressor could be removed. When the head had been taken off, it was found that one of the discharge valves in the casting had been forced wide open on account of a broken spring.

On another occasion I had just spoken to the fireman and everything in the boiler room seemed to be in good order. When I went back to the engine room I noticed that the engine and pumps ran slower and that my steam gage showed only 60 lb., while the fireman's gage, at which I had just looked, showed 105 lb. This was a mystery to me and I notified the chief, who at once gave the fireman orders to bank the fires and close the stop valve on each of the two boilers that were running.

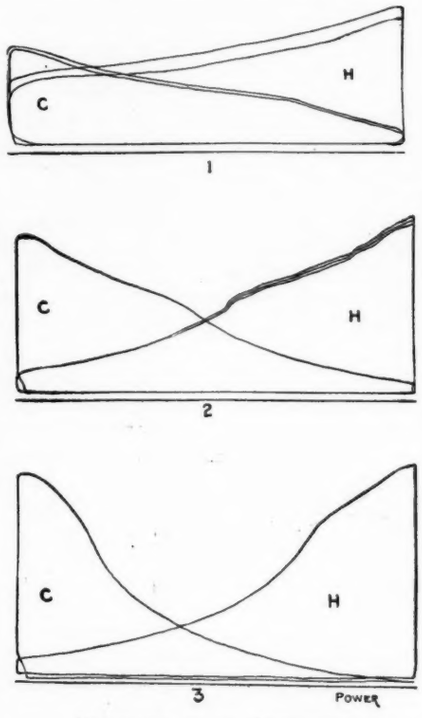
Above the stop valve on the boiler there was another valve in the main steam line. Upon taking the bonnet off this valve it was found that the stem on the disk had broken off and had fallen on its seat, partly shutting off the steam supply to the engine room and thus causing the drop in steam pressure.

WILLIAM S. KEIL.

Philadelphia, Penn.

Diagrams for Criticism

Here are three indicator diagrams, taken from the ice machine in our plant, on which I would like readers of POWER to comment. The engine, 14x14 in., has a Meyer cutoff and I was told by the makers' representative that the most economical point was where I took the first diagram. I would like to hear from readers as to adjustment for equal load on both ends of the cylinder and as to whether diagram No. 1 or No. 2 shows the most economical running conditions.



DIAGRAMS TO BE CRITICIZED

G. L. LYONS.

New York City.

What a Knock Revealed

While in conversation with the manager of a meat market, he told me that an ice machine which he had installed a short time before was giving very poor satisfaction. The company installing it had upon his request sent two men out to the plant at different times. The first advised him to put more ammonia in the system. When the next man came he took out about the same amount as had been put in. Before leaving he advised the manager to replace his compressor with a new one, it being second-hand.

The first thing I observed was a peculiar knock or pound which was noticeable on only one stroke of the piston. Next, the discharge pipe from one end of the cylinder was nearly cold while the other was quite hot. I said I believed that the discharge valve was stuck. That night he examined all the valves and found the discharge valve held from its seat by rust and other foreign matter from the pipe lines.

The compressor had been working on one end only and after cleaning the valve and valve seat the knock ceased and the compressor worked to its full capacity.

DELBERT J. MEANS.

Indiana, Penn.

Alarm for Cold Storage Room

The falling temperature of a cold-storage room might at some time result in a large loss to the company, so I have rigged up the alarm shown in the accompanying sketch. It is made as follows:

Take a glass tube 7 or 8 in. long and ⅜ in. in diameter, close the bottom end with sealing wax and through it insert the bare end of a No. 18 magnet wire. Fill the tube about three-fourths full of mercury and on top of the mercury put a float of wax in which the bare end of a magnet wire is inserted and bent as shown in the sketch.

The tube of mercury is fastened to a base with clips of metal. At the upper end of this base an adjustable lever is attached and the electrical connections are made as shown in the diagram.

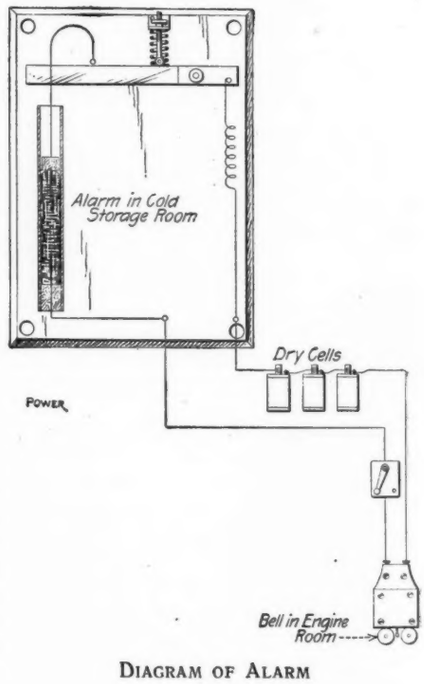


DIAGRAM OF ALARM

Should the temperature in the cold rooms fall during the day or night the mercury will contract and the float in descending will close the circuit so that the bell will ring and warn the engineer. The adjustable lever allows setting the alarm for various temperatures.

MARTIN MCGERRY.

Holley, N. Y.

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POWER

Cotton Rope Drive

It has been said, and may be true, that the reason why cotton rope has not been a success in this country as a transmission material is that American manufacturers and engineers, though progressive and willing to try new things, are not sufficiently analytical and thorough in their trials. They will install a drive, and if it is a success, well and good; if it is unsatisfactory, it is discarded without attempting to discover why and to eliminate the cause. Abroad, manufacturers and engineers are progressive in a far different way. If a thing fails there, a careful, systematic study is made as to why it failed and the cause of failure is removed if possible. Sometimes a few minor changes will result in a drive which was formerly a failure becoming a decided success.

Not many years ago an American engineer installed a rope drive in a large plant. He had no experience whatever in the designing of this type of drive, and he laid out the grooves in the pulleys in accordance with his ideas. The drive lasted but a short time, and the whole output was consequently scrapped without hesitation and belts at once replaced the ropes. The entire trouble was due to the faulty design of the grooves.

This same experiment was tried much earlier abroad and the results were similar, but the rope drive was not thrown out. The engineers experimented with different forms of groove and shortly discovered the right shape for the conditions; after this was found the rest was easy. The drive was far superior to the belt and it has remained in service ever since.

It is to be noted that unless the grooves are properly shaped and adapted to the material of which the ropes are made, no rope drive will be a success and none should be installed without first carefully considering the character of the material employed and the conditions under which the drive is to be used. Correctly designed and constructed, a rope drive is a very satisfactory method of transmitting power—in many instances it is superior to belt or electric drive—and is at the present time one of the best methods of operating shafting which is a considerable distance from the driving engine.

Control of American Water Power

The report of Commissioner of Corporations Smith, on the development and control of water-power in the United States, is of interest to the public, but it particularly claims the attention of engineers.

With the development of high-tension electric transmission, hydro-electric practice has grown steadily and rapidly. Because of this there has come into existence what would soon become a complete monopoly of this important field. The report states that ten large groups of industrial interests own and control 60 per cent. of the total developed water-power in the country as well as many undeveloped power sites. As the maximum available waterpower, according to the United States Geological Survey, is between sixty-six and sixty-seven million horsepower, the question of ownership is one of grave concern, and the commissioner warns against the tendency to monopolistic control of such an immense industrial asset and recommends the encouragement of more extensive water-power development by an equitable leasing system. This is in accord with the recommendations of Pinchot, Newell, Garfield and others active in the conservation program of the Roosevelt administration.

That the federal government should retain the control of the fourteen million horsepower of water power now owned by it is not only progressive conservatism but good business management as well, and the people should receive the benefits to be derived from its use, allowing a fair profit to the enterprising

individual or corporation which develops it.

The total stationary-engine power in use in this country is approximately thirty million horsepower, and the total developed water power is about six million horsepower. The additional water-power now susceptible of economical development is estimated at nineteen million horsepower. It is further estimated that the water-power now in use effects a saving of thirty-three million tons of coal a year; when all the available water power is developed, one hundred and fifty million tons a year can be saved. The obvious importance of this will be more forcibly realized when it is recalled that coal can be used but once, while water power is inexhaustible.

From the capitalist's viewpoint, the economy of operation of the hydro-electric plant is the strongest stimulus to its development. Where the market area to be served is great and the individual power sites are small and distant one from the other, the method of tying-in several plants on a single system of transmission lines seems to be a profitable one. During low loads a few of the plants could furnish service while those idle were accumulating "pondage" for reserve purposes.

It is this facility of combination that has led to monopolistic control of water-power. The present concentration of control in the hands of a few large financial interests interrelated by directorates and banks makes inevitable the passing of a great public asset into the realm of private control unless restrictive and protective legislation is the immediate outcome of the Commissioner's report.

Boiler Explosions

In his address before the American Boiler Manufacturers Association, at its recent New Orleans convention, S. F. Jeter said broadly that "there is one explanation for all boiler explosions; namely, the boiler or some part of it is too weak to withstand the stress brought upon it. There are many causes contributing to such weakness, and a definite cause can usually be given for most explosions."

Despite this assertion from one who is in a position to know, explosions continue to be frequent and fatal. Mr. Jeter assigns faulty design and carelessness of operation as the chief causes. It would seem that both causes were avoidable; surely the latter is, and there is no logical reason why the former should not be. It is true, the manufacturer has little to say about the operation of the boiler after its acceptance by the purchaser, but the responsibility does not end there; the owner and engineer are responsible to the community for its safe operation, and neither inadequate laws nor lax enforcement of the few good ones applying to this work should be tolerated.

Those who specialize on boiler explosions seem to be agreed that their causes are avoidable. If this is so, what action will follow the recent carnival of death-dealing explosions? To say that they were avoidable is equivalent to charging gross homicidal negligence in the light of expert opinion. The public and those engaged in engineering practice therefore are privileged to demand the enactment and enforcement of protective legal measures to determine the competency of the operating force to perform their work, and a through examination of the engineers and firemen will indicate their fitness to safely operate the equipment.

The doctrine of the "fellow servant" and "assumed risk" in its relation to boiler explosions will not long be accepted by people of intelligence if ignorance and negligence are the cause of so many explosions.

That poor feed water is frequently the initial source of such trouble is generally recognized, and its analysis and corrective treatment before its use, or perhaps its frequent removal from the boiler, should be made compulsory by law. To depend upon individual "common sense" is poor policy, as the sense of duty is often obscured by the present high-tension industrial conditions.

It is gratifying to know that the American Boiler Manufacturers Association—to whom belongs credit for the existence of the Massachusetts and Ohio rules—is making an effort the chief object of which is to minimize explosions by the adoption of uniform boiler specifications.

Its committee on boiler specifications has indorsed the Massachusetts rules and recommends the amendment of several paragraphs, substituting improvements. Among others, it is recommended that the allowable pressure on an all cast-iron boiler be reduced from twenty-five to fifteen pounds per square inch. The committee objects to basing the factor of safety on the age of the boiler, contending that it should be determined by its physical condition. This contention should receive the approval of all acquainted with everyday boiler practice.

Many other equally important amendments are proposed which it is to be hoped will be adopted. The provoking feature of it all is the indifferent attitude displayed by those who should aid the association in its commendable work.

American progress seems to be so rapid that little attention is paid to the evils incurred by it. Would it not be better to proceed more slowly and correct the evils that really impede progress than to seek consolation in the barbaric plea that such fatalities are inevitable accompaniments of an advanced civilization?

"And the coroner laid the blame on the dead engineer." For most accidents this expression seems to permanently fix the blame and the incident is closed. There are times when this verdict is a true one, but are there not others where an investigation of actual conditions by some interested engineer would free his dead brother from the stigma of gross carelessness and criminal neglect? It is a long time since the daily press has given utterance to any defensive theory from a practical operating engineer. Why?

"We occasionally get together in our power plant and discuss features of practical operation," writes a chief engineer. This is a most efficient way to get that "teamwork" which is so necessary to successful operation. The men better understand their chief, and sometimes even the chief learns something.

Pittsburg has a plan to abate its smokiness by utilizing the 100,000 hp. which can be developed by its near-by rivers and streams. If this can be accomplished, the city will be entitled to spell abatement with a capital A.

A power superintendent advocates placing the chief engineer's office in the boiler room. He believes the engineer should be "the man on the spot" if he would prevent a high heat loss and uneconomical combustion.

Boiler Explosion at Greentown, Penn.

By Carl H. Beach

Due to corrosion of the stays, an old single-riveted lap-seam boiler exploded, killing four and seriously injuring a fifth man. The building was demolished and the boiler hurled into a creek two hundred feet distant.

Shortly before 7 o'clock on the morning of Friday, Mar. 7, the boiler in the T. H. Gilpin Stick Factory, of Greentown, Penn., exploded, killing four men and injuring one other, besides demolishing the house in which it stood.

The main factory building is a two-story frame structure, approximately 80 x150 ft., with the engine and boiler rooms in a wing at one side, as indicated in Fig. 1. The boiler was of the return-tubular type, and the failure occurred in the front tube-sheet, thus driving the boiler through the back of the building up along the bank of the millrace to a point about 100 ft. from its original position, where it struck a tree at a point about 8 or 9 ft. above the ground. The tree doubled up like a jackknife and was carried bodily with the boiler a distance of some 30 ft. or more. At the point where the boiler apparently struck, the tree was about 14 in. in diameter, and at the surface of the ground where the tree also broke off, it was some 18 or 20 in. in diameter. Fig. 4 shows the tree in the position in which it was left by the boiler, the stump from which the tree was removed being shown in the lower right-hand corner.

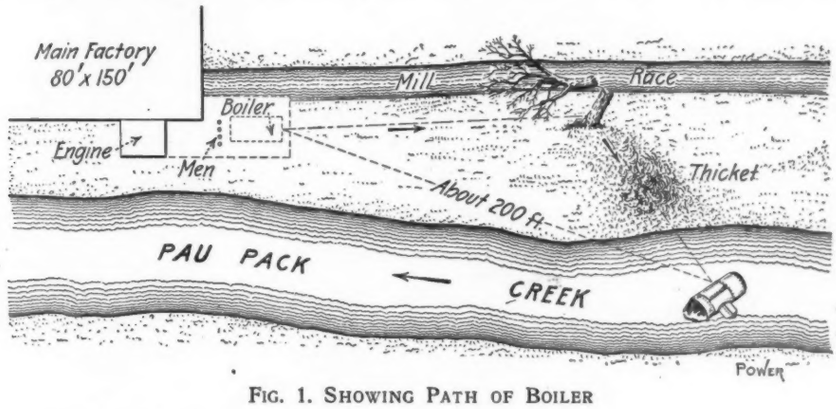
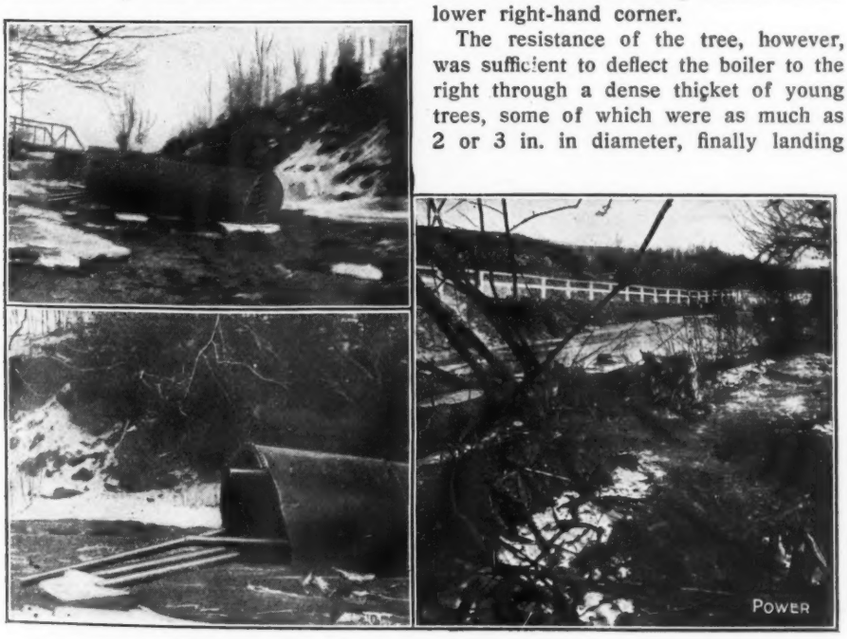


FIG. 1. SHOWING PATH OF BOILER

The resistance of the tree, however, was sufficient to deflect the boiler to the right through a dense thicket of young trees, some of which were as much as 2 or 3 in. in diameter, finally landing in Pau Pack Creek in the position shown in Fig. 2. The impact of the tree also apparently caused the boiler to turn end for end, so that the end in which the failure occurred and which originally faced the engine room was found to be pointing upstream, or in exactly the opposite direction.



FIGS. 2, 3 AND 4. SHOWING REMAINS OF BOILER AND THE TREE WHICH WAS UPROOTED BY IT.

The four men killed were sitting in front of the boiler, and when the failure occurred they were blown bodily through the roof of the boiler house. Three of them were so completely dismembered that a search of some two hours or more was required before sufficient remains were obtained to identify them. The fourth man was mortally injured and died shortly after.

A boiler explosion seems incomplete unless someone miraculously escapes, and this accident was not an exception. There was an entryway between the boiler room and the engine room, the walls of which were of light boards, and, although the impact of the explosion entirely demolished the walls on two sides of this room, the fireman who was in the room was only slightly injured. The failure of the tube-sheet also blew the fire from under the boiler onto a large pile of shavings and scrap; yet the shavings were not ignited, seeming to indicate that a large quantity of water must have promptly extinguished the fire.

It is understood that the boiler had been purchased about 28 years ago and was at that time second-hand. It had single-riveted lap joints on both the girth and longitudinal seams, and the rear head was supported in the manner shown in Fig. 5. The failure occurred not through the riveted joint, but through the solid plate at *a*, the appearance of the fracture being more that of a piece of wood that is pulled apart than of a piece of metal; in other words, the fracture appeared very much splintered, and in some cases even honeycombed. About two-thirds of the tube-sheet was carried away.

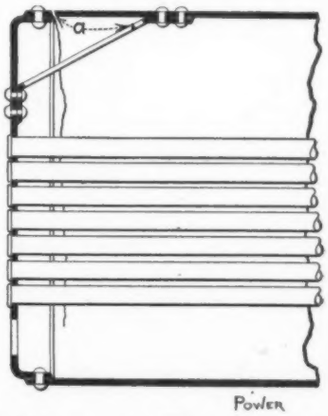


FIG. 5. INDICATING WHERE SHELL TORE

The portion of the tube-sheet above the line of tubes was stayed by wrought-iron diagonal stays, and all of these broke

near the shell, the body of the stays being carried away with the tube-sheet. The top row of tubes was also carried away with the tube-sheet, having pulled out of the front head.

The shell was ¼ or $\frac{5}{16}$ in. thick, the tube-sheet being about ⅜ in. There were 40 tubes 4 in. in diameter. In no place was it possible to ascertain the diameter of the rivets, owing to the amount of corrosion. No trace of the safety valve was found and there appears to be some contradiction as to the exact steam pressure carried at the time of the explosion, although it is believed to have been about 80 lb. per square inch.

The inside of the boiler was clean, but the portion of the break that was exposed most directly to the fire was inaccessible, as it lay in the water and could not be reached easily.

The failure was undoubtedly due to the stub ends of the stays being badly corroded. The stays on the front head were also in bad condition, although they had not broken.

San Antonio Locomotive Boiler Explosion

Passenger engine No. 704, of the Southern Pacific R.R., exploded while standing in the yard at the railroad stop at San Antonio, Tex., at 9:30 Monday morning, Mar. 18. Twenty-eight employees were killed and more than 40 persons were injured. Part of the roundhouse collapsed, several small buildings were demolished, and the engines in the roundhouse were badly damaged. It is

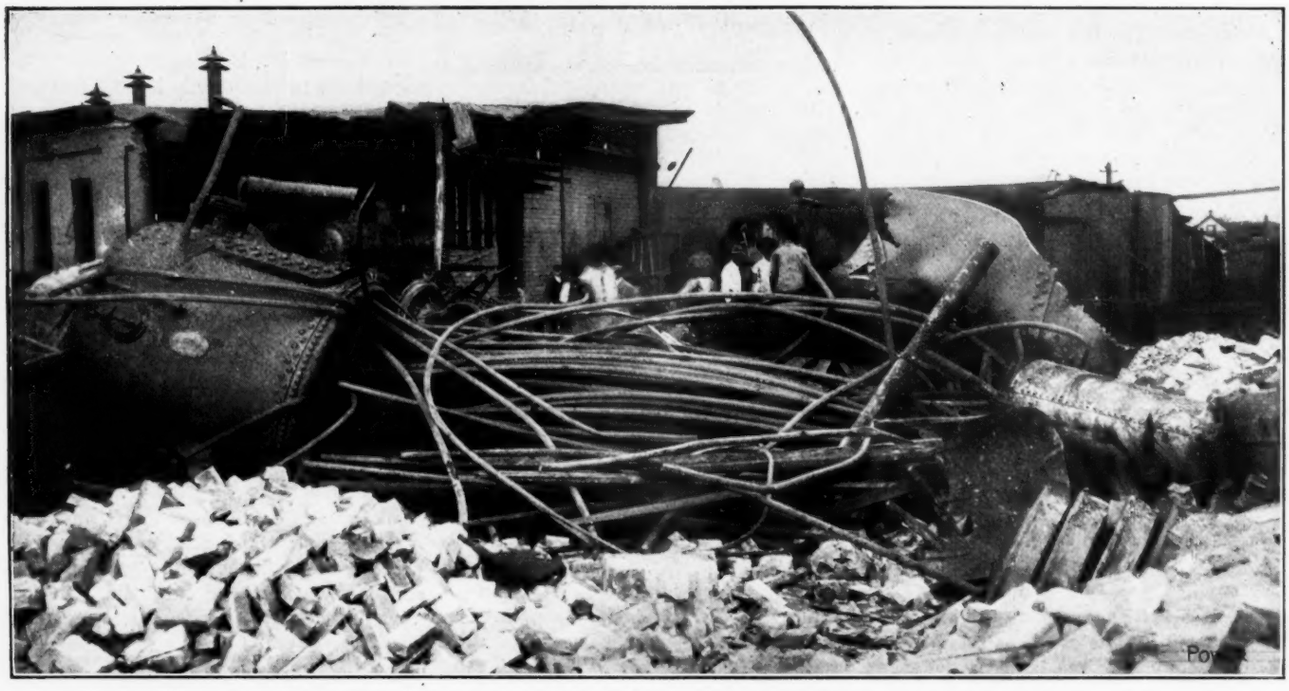


FIG. 1. ALL THAT WAS LEFT OF THE LOCOMOTIVE BOILER AFTER THE EXPLOSION

FIG. 2. VIEW OF LOCOMOTIVE DRIVING TRUCK AND BOILER REMAINS

estimated that the monetary loss will reach the sum of $200,000.

The probable cause of the explosion was excessive steam pressure. This belief is substantiated by the testimony of employees who stated at the Interstate Commerce Commission investigation that a workman had screwed down the safety valve just previous to the explosion and that the oil burners had been extinguished and then relighted shortly before the accident. All theories regarding dynamite and other explosive forces, which were at first given some credence, have been dropped by the investigating board.

In Fig. 1 are shown the wrecked engine and roundhouse. All that is left of the boiler shell is the crumpled and torn sheets, shown beyond the tube. The only part of the boiler which remains is the extension front, shown in the foreground, and the mass of tubes, some of which are still intact in the front tubesheet.

Fig. 2 shows the engine frame after the wreckage had been cleared away from around it, and gives a view of the boiler ready for the government inspector. The rear driving wheel was blown clear of the shafting, but was prevented from further flight by the side-rod connection.

A closer view of the wrecked boiler, with the running gear of the engine in the center and the roundhouse at the right, is shown in Fig. 3. The force of

FIG. 3. NEAR VIEW OF BOILER, SHOWING THE TORN BOILER PLATES

FIG. 4. VIEWS SHOWING VARIOUS PARTS OF THE WRECKED LOCOMOTIVE

the explosion tore the steel boiler plates into shreds, which from the condition of the riveted joints which are uninjured, indicates that the internal pressure must have been excessive.

The group of photographs shown in Fig. 4 illustrate several parts of the exploded locomotive. A near view of the torn boiler sheet and a portion of the firebox are shown; the position of the driving truck, one wheel of which is still upon the rail, gives an accurate idea as to the extent of the damage to the locomotive. It would appear from the two remaining photographs that the explosion was more severe at the firebox end of the boiler, as the front end was carried only a short distance, while the firebox end was thrown almost at right angles to the original position of the engine. That the boiler tubes and front extension were not thrown a greater distance is doubtless due to the giving away of the boiler shell in its entirety at practically the same moment.

THE REMAINS OF BOILER MINUS BOTH HEADS

The photographs indicate that the initial rupture occurred in the firebox and was probably due to the failure of the staybolts which were in many instances broken in two in the center. This is doubtless the most disastrous locomotive explosion that has ever occurred.

National Gas Engine Show

The National Gas Engine Association will hold its first national show at Milwaukee, Wis., on June 17 to 22, in the Auditorium, where 100 exhibition spaces have been laid out. The convention of the association will be held at the same time.

Boiler Explosion at Salisbury, Md.

BY F. A. GRIER, JR.

A very disastrous boiler explosion occurred on Mar. 26, at 2 p.m., seven miles northwest of Salisbury, Md., killing six persons and injuring three others. The boiler was a return-tubular with extension front; the kind commonly used in country sawmills, such as the one in which it was used at the time of the explosion. The mill was owned and operated by Hermus Hearn, who was killed; 10 men were working in the mill.

The boiler was 44 in. in diameter and 14 ft. long, with 46 three-inch tubes; the shell was originally $\frac{5}{32}$ in. thick, the heads $\frac{3}{8}$ in. thick. The boiler was purchased second-hand five years ago and had probably never been tested since it was first built, as few of the country sawmill owners ever go to that trouble, and there is no law compelling boiler inspection in Maryland outside of the city of Baltimore.

The safety valve was of the old style ball-and-lever type and in addition to the regular safety weight there was a cast-iron cogwheel or rack pinion wired to the lever. The boiler had been standing idle all winter until a few days before the explosion, which occurred just as the engineer opened the throttle valve of the engine. The force of the explosion landed the shell 80 yd. away, tearing both heads out and landing them 20 yd. beyond the shell. Only nine of the tubes remained with the heads; the others were blown in all directions, some of them as far away as 200 yd.

The Diesel Engine

In a paper read before the British Institution of Mechanical Engineers on Mar. 15, Dr. Rudolph Diesel reviewed the history of his now famous engine and pointed out some industrial advantages obtainable by its use, especially in Great Britain. Foremost amongst these, naturally, he placed the conservation of the country's coal supply which would result from displacing steam engines with Diesel engines using tar oils as fuel. He also suggested the possibility of using vegetable oils for engine fuel and cited a test made with peanut oil a few months ago, in which the consumption was 0.53 lb. per brake horsepower-hour; the heat value of the oil was 15,500 B.t.u. per pound and it contained 11.8 per cent. of hydrogen.

In referring to the advantages of the oil engine for service in the colonies, Dr. Diesel expressed the opinion that Great Britain should emulate the progressive example set in the Congo, where a pipe line 250 miles long is under construction for the transfer of crude petroleum.

In an appendix Dr. Diesel presented a general list of oils suitable for consumption in his engines. Those which can be always utilized are mineral oils free from benzine; lignite-tar oils, and fat oils from vegetable or animal sources, such as castor oil, fish oil, peanut oil, etc. With the aid of special apparatus, it is practicable also to use pit coal-tar oil and tar from vertical water-gas and oil-gas ovens. Tars from horizontal and inclined retorts cannot be used in the Diesel engine as yet.

In another appendix the author gave a condensed summary of the vessels thus far equipped with Diesel engines. This list includes 20 oil tank vessels, one of 15,000 tons; 37 tugs, of which 22 are Russian; 8 sailing vessels; about 40 merchant vessels, one of which is of 9000 tons displacement; 14 fishing boats; about 115 submarines, ranging up to 5000 hp.; about 25 gunboats; 20 small naval boats, and 16 miscellaneous boats, mostly yachts.

The "Florida" Is the Fastest Battleship

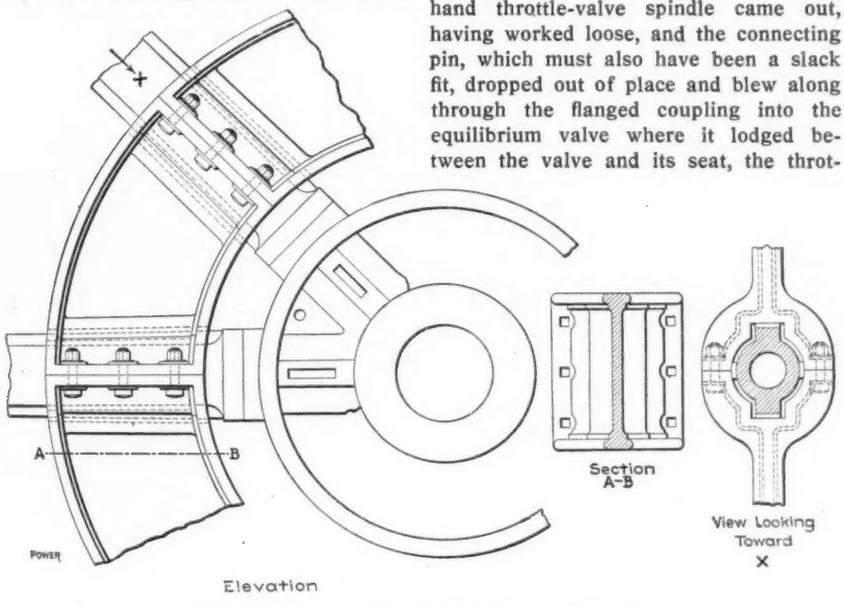
In its test on Mar. 23 in a rough sea and brisk wind off the Maine coast, the government-built battleship "Florida," by attaining a speed of 22.54 knots, set a world's record. The British dreadnaught "Vanguard" heretofore held this record with a speed of 22.50 knots. The "Florida" was built at the New York Navy Yard under the supervision of Naval Constructor William J. Baxter. Her normal displacement is 21,825 tons, and she is manned by about 900 officers and men.

Explosion of a Beam Engine Flywheel

By John S. Leese

The flywheel of a beam engine in a mill at Lancashire, Eng., burst some months ago under the following circumstances: The engine, which was bought and installed in 1845, was a double-acting condensing compound throttle-governed unit of about 200 hp. and ran at 40 r.p.m. In the course of its life the engine had naturally been improved and strengthened as the load increased, and the flywheel was strengthened in 1880 by the addition of a loose boss fixed onto the flywheel spokes in the manner shown in the accompanying illustration, which is an old tracing made at the time of the alteration.

Between this extra boss and the rim of the wheel were placed eight 2½-in. diameter radial stays, tensioned and fastened by nuts. These were placed midway between the eight arms of the wheel,



Views Showing Construction of Flywheel

which was built up of eight segments and had the following dimensions: diameter, 14 ft. 6 in.; rim section, 10x7½ in.; arms, 10 in. diameter. To the flywheel was bolted a gearwheel with 208 teeth of 2.77 in. pitch, which meshed with a wheel with 74 cogs for driving the line shafting in one of the weaving sheds. The other leading dimensions of the engine at the time of the smash were as follows: high-pressure cylinder, 19¼x30 in.; low-pressure cylinder, 26$\frac{13}{32}$x60 in.; diameter of high-pressure piston rod, 3$\frac{5}{8}$ in.; low-pressure piston rod, 3¾ in.; nickel-steel crankpin, 5 in. The engine was supplied with steam by either or both of two Galloway boilers, working at 105 lb. per square inch pressure.

In January, 1909, the crankpin broke, and caused considerable damage. The high- and low-pressure cylinders were broken, the beam was fractured and many other and minor parts were damaged. This accident was attributed to the fact that the crankpin was hollow; it had been taken from a larger engine and turned down to 4¾ in., and the pin being hollow, it was too little to hold.

In July, 1910, the cast-iron connecting-rod was found to be fractured, although at the time of the smash in 1909 it had been very carefully examined and no trace of a fracture was found. It was replaced by a steel rod which was on the engine at the time of the accident about to be described.

The equilibrium (or governor) valve was connected flange to flange with the engine hand-throttle valve, the governor valve being on the engine side. After the noonday stop, the engineer cracked the throttle open to warm up and ran the engine slowly for the afternoon load, there being no load on the line shafting at the time. The split-pin securing the connecting pin between the disk and the hand throttle-valve spindle came out, having worked loose, and the connecting pin, which must also have been a slack fit, dropped out of place and blew along through the flanged coupling into the equilibrium valve where it lodged between the valve and its seat, the throttle valve being disconnected from its spindle and dropping wide open.

The result was to allow a full head and pressure of steam through the wide open and disabled throttle and governor valves into the engine, which was without load. Therefore, before the engineer could get over the distance to the boiler stop valve, the engine had attained a speed that the patchy flywheel could not hold out against and it let go, doing considerable damage to the adjoining weaving shed, partially wrecking the engine room, smashing two looms and making a total wreck of the engine. Luckily, no one was injured and the presence of another engine saved the mill from total stoppage.

The writer is inclined to the opinion that the spokes would be the first to let go. It would appear to be extremely difficult to tension the eight strengthening stays previously mentioned to take an adequate share of the load and, if this theory is correct, they would be quite unable to handle the load suddenly thrown upon them by the failure, in the first instance, of one or more of the spokes.

London International Smoke Abatement Exhibition

From Mar. 23 to Apr. 4, this exhibition was held in the Royal Agricultural Hall, Islington, London. The last international exhibition of this character was held in London in 1881; and considerable progress has been made in the methods and apparatus for securing the smokeless combustion of fuel that have been worked out and applied practically in the 30 years that have elapsed. It was, of course, unfortunate that the preparations for the 1912 exhibition should have been overshadowed by the disastrous coal miners' strike, and it may seem somewhat ironical to hold a smoke-abatement exhibition in London when the chief problem confronting English manufacturers was "how to get coal to burn" rather than "how to burn it without producing smoke."

The participation of foreign manufacturers and inventors in the exhibition was not so great as was expected, many manufacturers stating that a fortnight's exhibition was too short for them to recoup themselves for the necessary expenditure. The strike also prevented some of the English exhibitors from sending their exhibits, owing to the curtailment of the railway service for goods. In spite of these difficulties an interesting show of smoke-abatement apparatus and appliances was obtained.

Conferences were held under the presidency of Sir William Ramsay, Sir William Richmond and Lord Justice Moulton, and a large number of interesting papers were presented. In a later issue a résumé of the papers and discussions will be printed.

Special Meeting of Mechanical Engineers

On Tuesday evening, Apr. 9, the American Society of Mechanical Engineers in New York City will hold a special meeting in honor of the Commission of the German Museum of Masterpieces of Natural Sciences and Technical Arts which is visiting this country to inspect industrial establishments, museums, libraries, etc. Dr. Oscar von Miller, member of the House of Lords of Bavaria and president of the Verein Deutscher Ingenieure, who heads the commission, will deliver a lecture on its work with special views showing the interesting features of the Bavarian Technical Museum which has no counterpart in the world.

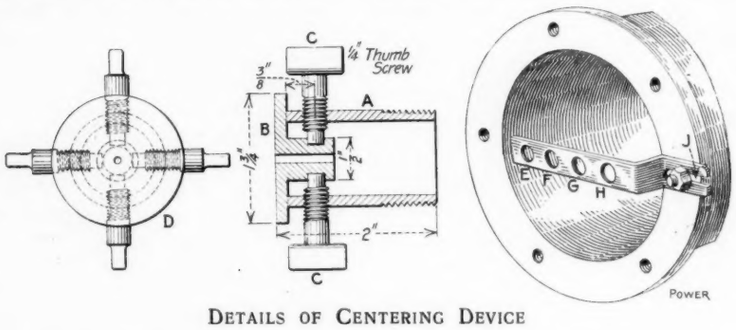
Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Centering Device for Cylinders

The figures shown herewith illustrate a convenient device for centering cylinders which has been used by several engineers with very satisfactory results.

Referring to the illustration, *A* is a short piece of 1-in. wrought-iron pipe, one end of which is faced off. The other end is threaded as shown; *B* is a carrier for the centering cord or wire. Four holes are tapped in the piece *A* at right angles, as shown in the end view *D*. By means of the thumb-screws *C*, which fit in the groove in *B*, adjustment of the cord is made.



DETAILS OF CENTERING DEVICE

On the cylinder head is a piece of wrought iron, offset as shown. *E, F, G* and *H* are holes tapped for 1-in. pipe to receive the piece *A* and provide for its use with different diameters of cylinders. The slot *J* is for bolting on by the cylinder-head studs and to provide smaller adjustments than those given by the tapped holes. Final adjustment is made by the thumb-screws *C*.

The offset holder is bolted at one side only and provides convenient access to the cylinder.

CARL L. SVENSEN.

Tufts College, Mass.

Asbestos Drum Covering

In our plant we have a 200-hp. boiler, the drum heads of which stick out past the brickwork. I tried several ways of coating the heads with asbestos, such as mixing it to the consistency of putty by adding water and applying this by molding it into small balls the size of a marble and tossing them against the head, but they would not stick.

Then I tried painting the head with shellac and applying the asbestos dry, but this did not work. I did not have a supply of litharge. Next I mixed the asbestos with water so that it would just about run. I used a pointing trowel and, placing a small amount on it, threw the mixture against the heads in spots. When this dried I went over it again in the same way until the head was well covered. Several thin coats were applied, letting each one dry well, until I had the covering the thickness required.

When applying the last coat I troweled it down and then, taking a whitewash brush, wetting it and rubbing it over the last coat, and following it up with the trowel, I got a fine finish, almost as smooth as glass.

HARRY E. KOFFEL.

Doylestown, Penn.

Packing and Gasket Cutters

Nearly every engineer has tools of his own invention, which, although not suitable for the market, are often very handy to the man on the job.

I have a number of small belts, 3 and 4 in. wide, which run very tight on the pulleys. In the case of these belts coming off, I use a hook to pull the belt up on the pulley. It is made of ¾-in. pipe, as shown in Fig. 1, and can be easily pulled out of the hand in case it catches in the pulley.

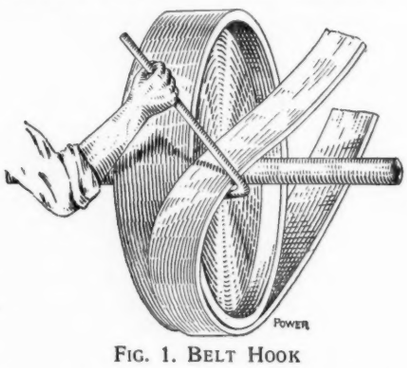


FIG. 1. BELT HOOK

Another useful tool is made of short pieces of brass tubing, a number of different diameters. In cutting belt holes in gaskets, markers, etc., these pieces of tubing are handy. I use a piece of wood and a hammer when cutting, as shown in Fig. 2, as the wood protects the tube-edge. I have an old file connected to a hard-wood board, as in Fig. 3, for cutting spiral packing to short lengths. The file edge, which comes against the board, is ground down to a razor edge. It can be used in cutting small belts.

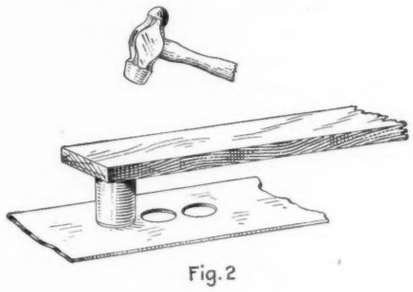


Fig. 2

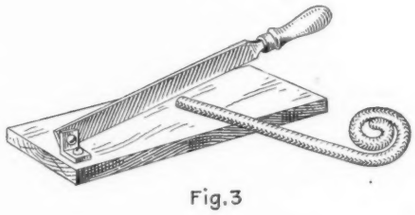


Fig. 3

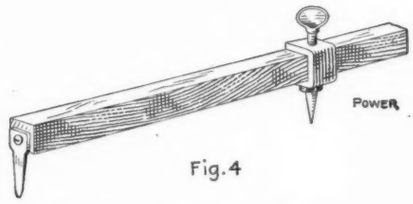


Fig. 4

GASKET AND PACKING CUTTERS

For cutting large gaskets, I took an old jackknife blade and chiseled a hole ⅛ in. in diameter and 2 in. from the end, sharpened the back and front edges and attached the blade by means of a short screw to a piece of hard wood 1 in. square and 2 ft. long. In a piece of soft iron ¾ in. wide and ½ in. thick, two holes were drilled, one ½ in. from the end and the other 2 in. from the same end. I then bent the iron to fit the piece of wood and threaded the holes. A bolt sharpened on the end fills the lower hole, and a thumbscrew fills the upper hole. The tool is shown in Fig. 4.

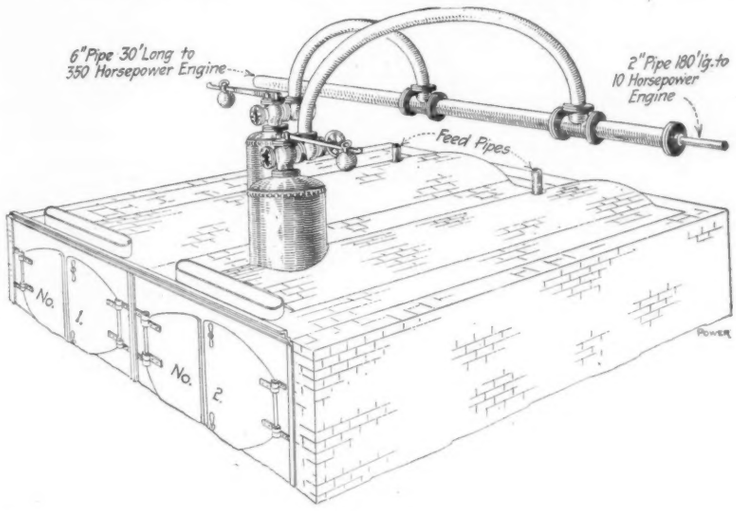
To cut any diameter of washer, move the slide containing the pivot to the point desired and move the knife in a circle.

A. D. PALMER.

Roxbury, Mass.

Boilers Transfer Water

The accompanying diagram shows the steam connection of two boilers. If both are filled nearly to the point where the high-water alarm whistle will blow, and the water from both boilers is then shut off, after 10 or 15 min. No. 1 will begin to blow with high water and the water will gradually go down in No. 2 boiler. There is no connection between the boilers with the exception of the 6-in. steam header.



PIPING OF THE BOILERS

I say the pressure of one boiler holds the steam back in the other boiler, but the other engineer says it is because No. 1 boiler is the best steam maker. They are both connected to the same stack.

I would like to hear from engineers who have had similar conditions and have found out the cause.

W. E. WARNER.

Springfield, Mass.

Arrow Pointed Wrong Way

Some time ago, when enlarging a power plant and using the loop system of high-pressure steam distribution, it was necessary to use reducing valves at four points to supply the various boiler- and engine-room auxiliaries, and for factory purposes.

The reducing valves were ordered and put in place with a stop valve connected to the reducing valve and between it and the boilers. On three of the lines the valves regulated to a nicety, reducing from 175 to 80 lb. gage; but the fourth valve would not give satisfaction, having a tendency to stick wherever it was put.

Thinking that it was sticking in the sleeves somewhere inside, I had it taken down and eased off; on putting it back I was disappointed in finding no improvement. I then removed the asbestos covering, thinking that it may have been put in wrong, but the arrows showed that it was properly installed. The other three reducing valves were giving splendid satisfaction in their respective branches, so I decided next week-end to take one of the good valves down and check it with the faulty valve, but found everything identical in construction. I then noticed that the opening in the valve appeared to be in reverse position to the good one, and so without doing anything more I put it back in a reverse position to the arrows showing on the valve body. It now works properly along with the others.

P. BROCKIE.

Montreal, Can.

Wrong Holes in Flange

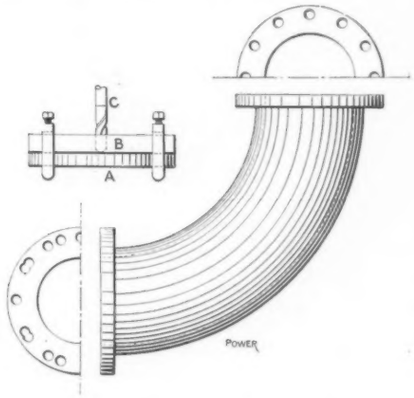
At a factory power plant an unaccountable incident occurred which caused the loss of half a day's production of about 1000 looms.

A crack developed in a 10-in. cast-iron elbow in the main steam pipe and an order was made out for one long-radius, cast-iron elbow with the flanges drilled for twelve ¾-in. bolts, the holes to be drilled on the seam. This meant that the starting point for drilling must be at the joint, where the pattern came together in the mold.

In anticipation of the arrival of the new elbow, staging, chain blocks, rope slings and some new flange bolts were gotten ready so as to do a quick, thorough job. The elbow came by express and at shutting-down time the boiler stop valves were shut, the drip valves were opened and the cracked elbow was soon on the floor.

When the new elbow was hoisted into place it was found that one of the flanges was drilled from a 10-hole template. If the requisite tools had been on the premises the adjoining pipe flange would have been used as a template and a ⅞-in. drill run through the bolt holes and through the flange of the new elbow by hand. The new flange was marked while in position and the elbow taken to a local machine shop to be drilled.

As a guide for the drill a flat piece of iron about 1 in. thick was used and drilled through with a ⅞-in. drill. This hole was placed directly over the marks on the flange and clamped in place. Then another hole was drilled through the guide and flange, care being exercised to keep the flange, which was 1⅛ in. thick, level. This method of drilling the holes proved very effective, especially where the holes were drifted less than the diameter of the drill, and there was very little chipping and filing to be done.



FLANGE AFTER DRILLING

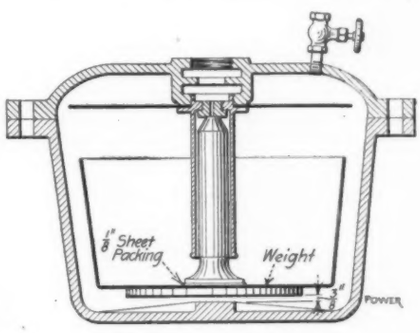
The sketch shows the elbow and flange *A* after it was redrilled, also the guide *B* clamped in position to guide the drill *C*.

J. W. PARKER.

Clinton, Mass.

Traps Did Not Work

I am employed at a mill that has been "grinding" 54 years and have found many traps of bygone days which had to be repaired and changed. These were of the bucket type and would not work on the 90-lb. duty, being made for less.



WEIGHTED BUCKET

The changes consist of making the valve seat with a much smaller bore and adding a cast-iron weight under the bucket, as shown in the illustration.

We had quite a few overhauled and they worked well, but there was one trap which would not shut after open-

ing. I looked it over and found that the bucket had a ⅜-in. drop when full. I reduced the drop to ⅛ in. and then substituted a 1/64-in. gasket in place of the ⅛-in. sheet packing at the joint of the stem and bucket, thus lessening the amount of water left standing in the bucket after the trap discharges. The trap worked well after these changes.

These same bucket traps gave some trouble by getting air-bound and not opening. A way out of the difficulty, and one well worth while, is shown in the sketch. Drill and tap a hole in the cover for a ⅛-in. iron pipe. Then insert a ⅛-in. extra-heavy close nipple and screw a ⅛-in. valve on the nipple, and let the valve remain open all the time, just enough to "sizzle." A lot of kicks and troubles will then vanish as the traps will never get air-bound again.

FRANK MARTIN.

College Point, N. Y.

Does Not Fear Central Station

If one-half the time wasted in berating the central station, and moaning over low wages were spent in improving plant conditions, there would be no kick coming to either the engineer or the employer. Those who buy engine-room equipment generally buy on a guarantee of efficiency, and have a right to expect regular statements from the engineer, as to whether they are getting what they have paid for.

I am operating an ordinary high-speed plant. My wage account for the night and the day fireman and self averages $3 per day more than the cost of fuel for the 24 hours. The average cost for power has been $0.0164 per kilowatt-hour from July, 1911, to January, 1912; this charge includes the cost of fuel, water, waste, oil, wages and interest, depreciation, insurance and taxes. The last four items amount to $4.22 per day. The average load is 1400 kilowatt-hours per day—60 per cent. power factor.

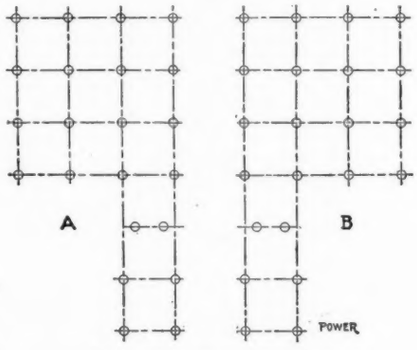
Considering heating as an expense, the annual saving over central-station power amounts to $4059.50, or a rate of interest of 24 7/10 per cent. per annum on the investment. I am not losing any sleep on account of the central station or wages. My daily cost and coal-analysis card are shown herewith.

D. L. DUNLAP.

Detroit, Mich.

Template Set Wrong

An incident was once brought to my attention that was a good example of the penny-wise, pound-foolish methods of some managers in employing incompetent men to do the work of a skilled engineer.



TEMPLATE WAS REMOVED

A company had been organized to build an industrial plant and the machinery had been ordered from a concern which proposed to furnish a competent erecting engineer, the purchasing company to pay him $7 a day and expenses.

The wise manager thought that this was a superfluous luxury as he had a local genius, who had never had any experience with the machinery to be installed. In the equipment was a machine requiring quite a substantial foundation, with the foundation bolts arranged as shown at *A*, in which the four end bolts were to be 8 in. lower than the others.

The makers furnished the template, fully marked, knocked down and crated and also a blueprint showing clearly the proper way to assemble it.

The local genius arranged the template as shown at *B*, and at last accounts it was over the foundation hole, with the foundation bolts in place and everything ready for the concrete work.

As the four end bolts are to hold down a Corliss steam cylinder, and as they are 16 in. too high, besides being on the wrong side, there will doubtless be an interesting time when the machine is placed over the foundation.

J. T. WILLIAMS.

Brownsville, Tex.

Thermometers on Condensers

Did any reader ever stop to think how many tons of coal could be saved in his plant by the investment of a few dollars in thermometers? During the winter, when the circulating water has a temperature of from 32 to 40 deg. F., it is an easy matter to lower the temperature of a condenser below that necessary to produce the required vacuum. Placing a thermometer on the discharge pipe of each condenser and regulating the circulating water according to its reading will result in raising the temperature of the hotwell a matter of 3 per cent.

Assume a daily output of 500,000 kw.-hr. at, say, a water rate of 16 lb. per kilowatt-hour, and see what a 33-deg. rise amounts to in tons of coal burned per day. These thermometers will also save on the amount of circulating water pumped and show whether a low vacuum is caused by high temperature or air leaks.

I have found that there is no use having a discharge temperature lower than 85 deg. F. on reciprocating work. Of course, the thermometers are useless unless looked at frequently. One might even go further and suggest recording instruments.

E. H. LANE.

Kansas City, Mo.

FORM 20

THE EDMUNDS & JONES MFG. CO.
DETROIT, MICH.

SAMPLE OF NAGOLA STOKER BOUGHT FROM DETROIT & PITTSBURG COAL CO.
OUR ORDER No. 3034 CAR No. C&O-33178 WEIGHT 100,000
BASE PRICE PER B. T. U. DELIVERED .075 per 13600 PRICE PER TON @ BASE .77
COST TO UNLOAD PER TON 0.20 TOTAL COST PER TON 2.37
ANALYSIS MADE BY RWR. DATE 12-22-11

MOISTURE	%	HIGH	75.75 °F
VOLATILE CARBON	%	INITIAL	71.00 °F
FIXED CARBON	%	RISE	4.75 °F
ASH	7.7 %	RADIATION	0.025 °F
SULPHUR	1.2 %	CORRECTION	0.2985 °F
FERRIC OXIDE	%	CORRECTED RISE	4.4765 °F
PHOSPHORUS	%	FACTOR	3117

B. T. U. PER POUND COAL 13,953
B. T. U. PER POUND COMBUSTIBLE
CALORIMETER PARR STANDARD.

NOTES

FORM 25-1M

THE EDMUNDS & JONES MFG. CO.
DAILY COST OF POWER & HEAT

DAY ENDING		RECORDED BY		
DAY COAL	LBS.	COAL PER K.W HR.		LBS.
NIGHT COAL	LBS.	COST OF COAL		
TOTAL COAL	LBS.	COST OF OIL & WASTE		
WATER	CU. FT.	COST OF WATER		
CYLINDER OIL	PINTS	COST OF SERVICE		
ENGINE OIL	PINTS	COST OF REPLACEMENT		
WASTE	LBS.	FIXED CHARGE		
CURRENT	K.W. HRS.	TOTAL DAILY COST		
REMARKS:—		NET COST PER K.W.HR		
		COAL COST PER K.W.HR.		

DAILY COST AND COAL ANALYSIS CARDS

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Transmitting Capacity of Pulleys

Recently I criticized a paper on the relative power transmitting capacity of cast-iron, paper, wood and cork-insert pulleys, read by Prof. Sawdon, of Cornell University, before the National Association of Cotton Manufacturers.

In replying, Prof. Sawdon fails to explain why his tests show totally different results from those obtained by Prof.

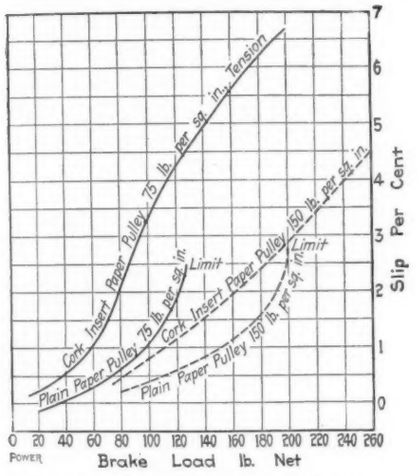

Cork Insert Paper Pulley 75 lb. per sq. in. Tension
Plain Paper Pulley 75 lb. per sq. in. Limit
Cork Insert Paper Pulley 150 lb. per sq. in. Limit
Plain Paper Pulley 150 lb. per sq. in.
Slip Per Cent
0 20 40 60 80 100 120 140 160 180 200 220 240 260
POWER
Brake Load lb. Net

FIG. 1. SLIP CURVES FOR PAPER PULLEYS WITH CORK INSERTS

Charles M. Allen, of the Worcester Polytechnic Institute, and George H. Perkins, of the Lowell Textile School, but, in taking exception to my criticism, calls attention to a few matters of minor importance, to which I reply as follows:

1. I did not include in the report of tests made at the Worcester Polytechnic Institute the tests of the vulcanized fiber pulley as I considered the results obtained of no value to anyone.

2. Although Prof. Sawdon writes that in my reply I cited but one set of tests: namely, those made at the Lowell Textile School, a reference to the paper, herein quoted, will show his error.

"As the results described therein do not fully accord with those obtained in similar tests made at the Worcester Polytechnic Institute, at the Lowell Textile School and with other pulleys in use under factory conditions, careful consideration and discussion seem desirable in order that we may consider the reasons for the differences referred to and establish the facts in the matter."

3. Replying to his statement that, "The losses between the belt and the pulley in a practical transmission rarely exceed about 2 per cent. and are often less," I refer again to his original paper in which is stated: "Many kinds of service demand at times overload capacities as much as 50 per cent. of the normal load," and I would like to know if these overloaded drives come within the class referred to in which the slip does not exceed 2 per cent.

4. While it is true that F. W. Taylor recommended a belt tension of 200 to 225 lb. for use on plain cast-iron pulleys upon upright machine-tool drives, neither he nor any other engineer will object to a lower belt tension when practicable and, as bearing on this, it may be of interest to note that Prof. Sawdon's tests were started at a belt tension of 37½ lb.

Equipping pulleys for such a test with but one-half the required cork area is

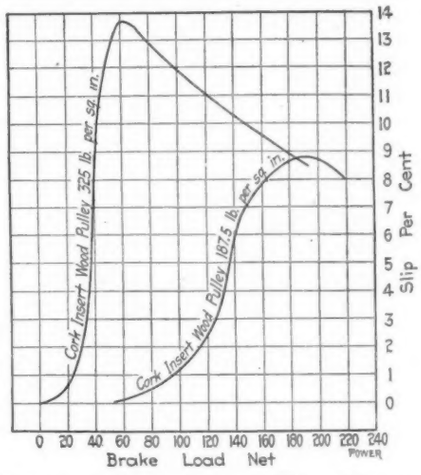

Cork Insert Wood Pulley 325 lb. per sq. in.
Cork Insert Wood Pulley 187.5 lb. per sq. in.
Slip Per Cent
0 20 40 60 80 100 120 140 160 180 200 220 240
Brake Load Net
POWER

FIG. 2. SLIP CURVES FOR WOOD PULLEYS WITH CORK INSERTS

bad enough, but to allow the corks to project 1/11 and 1/13 in. respectively, which projection tends to prevent the belt from making contact with the remainder of the surface of the pulley and thus reduces the actual area of pulley surface in contact with the belt, is still more disastrous to correct conclusions.

Furthermore, it was stated that: "unfortunately in the paper and in the corked-pulley tests the capacity of the machine did not permit of a high load being carried to determine the maximum values of the coefficient of friction and the corresponding slip," whereas upon examining the full report on file with the association it is found from the data sheets and diagrams that no reference is made to the behavior of plain paper pulleys at a slip exceeding 2.8 per cent., but the cork-insert paper pulleys are carried to loads of nearly double and at slips that reached nearly 7 per cent.—a somewhat surprising circumstance in the light of the foregoing quotation as to the limit of the capacity of the machine. I should like to know why Prof. Sawdon omitted to carry the paper-pulley tests beyond the low point at which these tests were apparently stopped and yet carried the cork-insert pulleys to the high point.

To make this point clear I submit a set of comparative curves (Fig. 1) taken from separate sheets of the unpublished portion of the original report, which speaks for itself.

Again, the cork-insert pulleys tested were not only equipped with but about one-half the required area of cork, but the cork was used under but 19 per cent. compression instead of 33⅓ to 50 per cent. as has been found desirable and is common practice.

I also submit another diagram (Fig. 2) from his unpublished curves of cork-insert wooden pulleys at belt tensions of 37½ and 187½ lb. respectively. This diagram shows that a pulley with a belt tension of 37½ lb. will lose in efficiency to a point of 14 per cent. slip with a load of 60 lb. and then gain in efficiency under an increasing load until the slip is but 8.75 per cent. with a load of 180 lb., at which point the pulley with a belt tension of but 37½ lb. will equal in efficiency a pulley operating under a belt tension of 187½ lb.—a result that seems as improbable as it is different from those obtained by others.

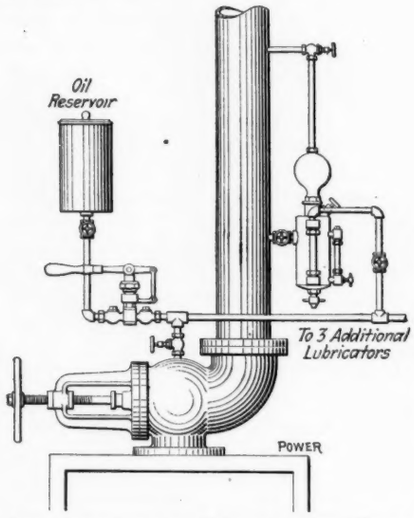
LAWRENCE WHITCOMB,
Treasurer, The Cork Insert Co.
Boston, Mass.

Oil Pump and Lubricator Filler

Mr. McGerry's letter in the Jan. 2[illegible] issue described an oil pump and lubricator filler. I have used a similar device for years, but I always connect the oil pipe to the plug at the top of the gage-glass, as shown in the accompanying figure, drilling and tapping the plug for a ¼-in. pipe, thus leaving the filling plug and hole in condition to be used at any time, should the pump fail to

work, or anything else go wrong. Another advantage of this arrangement is that it does not mar the threads or seat of the filling hole, and the lubricator can be filled by hand in the usual way.

Mr. McGerry advises drawing out the water in the lubricator body and the condenser through the drain-cock. This is poor practice. The condenser should not be emptied or allowed to get hot. Further, it is not necessary to drain the body through the drain-cock. Simply close the oil sight-feed valve and leave the water-feed valve open. Then, forcing the oil into the body of the lubricator will force the water out and up through the condenser and condenser pipe, into the steam pipe, both being kept cold with the cold water in the body. Closing the oil valve at the pump will then leave the lubricator ready to work at once.



ARRANGEMENT AND PIPING OF OIL PUMP

I have a hand-lever oil pump, similar to that shown in the figure, attached to a 5-gal. reservoir supplying cylinder oil to four lubricators, of from 1 pt. to ½ gal. in capacity, and located variously from 30 to 60 ft. from the pump, all fed through a ¼-in. pipe, with a valve close to each lubricator. The oiler opens the valve leading to the lubricator he wishes to fill, and gives the oil pump the required number of strokes. He then shuts the filling valve in the oil-supply pipe, and the lubricator is made ready for service again simply by opening the oil-feed valve in the sight-feed glass, which, of course, was closed before the pump was used.

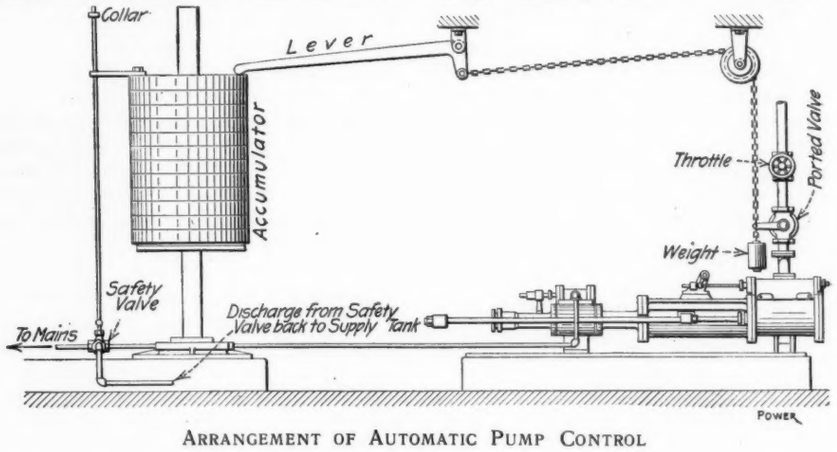
The ½-gal. lubricator sometimes gets hot, generally through carelessness, and I find that the quickest way in which to cool it is to close the sight-feed valve and force cold cylinder oil through it; the hot oil goes out through the condenser and condenser pipe into the steam pipe and thus it is not altogether wasted.

W. E. STICKNEY.

Prince Albert, Sask.

Step Bearing Pressure Regulator

Mr. Payne, in the Feb. 20 issue, details a very ingenious automatic pump control for a hydraulic pressure system. The apparatus looks to be very flexible in that it would be capable of controlling the pumps in remote locations with relation to the accumulator. The design of pump control herewith submitted is not



ARRANGEMENT OF AUTOMATIC PUMP CONTROL

new; it has been in successful operation in a cottonseed oil mill for several years.

By the use of the lever with the short projection, a reducing motion is secured whereby the ported valve in the steam line is controlled. This valve acts as an auxiliary to the throttle, which latter is set by hand to admit the required steam to run the pump at the desired speed.

The operation is simple and positive. As the accumulator rises the ported valve is closed through the medium of the chain and lever. In case of accident to the closing-off device, the accumulator rises to the collar on the safety-valve rod and the pump discharges direct to the supply tank.

F. C. HOLLY.

Memphis, Tenn.

Will the Injector Work?

In reply to Mr. Brouse's inquiry on page 340 of the Mar. 5 issue, I would say that while there is no doubt that two injectors can be made to feed at the same time, the layout of piping shown would hardly commend itself as being the best method for installing injectors in parallel. If the cut accompanying his letter is referred to, it will be seen that the two streams of water from the injectors will meet "head-on," so to speak, and then make a 90-deg. turn into the pipe leading to the boilers.

A much better arrangement would be to bring the line from one injector into the feed line with a 90-deg. elbow, and the line from the other injector into the feed line at a different point with a Y-fitting. If the piping is installed in this manner, I do not think that there will be any difficulty encountered in operating both injectors at the same time.

W. L. DURAND.

Brooklyn, N. Y.

I do not think the injectors will work; at least, they will not supply both boilers. The injectors are fitted with 1¼-in. steam and water pipes; therefore, only enough steam pressure will be had to work one injector, and there will be only enough water for one.

If Mr. Brouse will tap the city main with a 2-in. pipe and then reduce at the connections of the injectors to 1¼ in. and if he will tap the boiler with a 2-in. steam-supply pipe, and connect the discharge of the two injectors with a Y instead of a tee, it might be possible for them both to work at the same time, although under some difficulty.

I would advise that Mr. Brouse install the injectors separate from each other and also from the pump.

G. H. ROBERTSON.

Datura, Tex.

In the issue of Mar. 5, J. L. Brouse asks, will the injector work?

I see no reason why it will not, as the piping is proportioned about right. A much better layout, however, would be to do away with the tee between the injectors on the discharge and replace it with a long-sweep, double-branch elbow. This would lead the discharge from each injector in a more direct path to the boilers instead of allowing the injectors to butt against each other.

GEORGE H. HANDLEY.

Newburgh, N. Y.

Most assuredly the injector will work. He can work both injectors at the same time, he can work either one at the same time as the boiler-feed pump is working, or, if he cares to do so, he can work both injectors and the pump at the same time.

In the plant where I am employed there is almost identically the same piping and pump connections, and I have

tried them repeatedly and find it possible to work them in any combination or all together.

H. L. BURNS.

Caruthersville, Mo.

I do not think that the two injectors can be made to operate together; that is, if the second one is started it will break the stream from the first. I also think that the 1¼-in. pipe for the suction is not large enough for the two injectors. I believe that if the injectors were provided with separate suction pipes there will be no trouble.

WILLIAM H. KUCHENBROD.

Louisville, Ky.

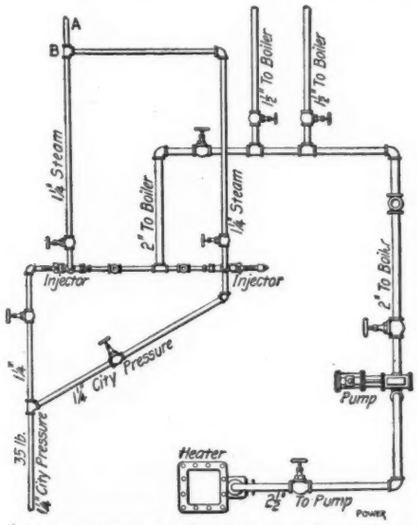
My theory is that the injectors will work, but they will not give the proper efficiency. My plan would be to put a Y next to the 2-in. elbow and have separate pipes to each injector, forming a gradual bend from the Y to the injector, and have the check valve not closer than 2 ft. to the injector. I have seen lots of injector troubles caused by not being connected properly and find that it is best to eliminate all elbows as far as possible.

WILLIAM T. HURD.

Bellefontaine, Ohio.

Answering J. L. Brouse I say that the two injectors will work on the same line at one time, providing steam line *A* be of 1¾-in. pipe to the tee *B*.

It seems to me that a better arrangement would be to have two suction pipes from the injectors running to a tank, and the city mains empty into this tank with a float valve to regulate the amount of water admitted to it.



ARRANGEMENT OF PIPING AND INJECTORS

F. P. SMITH.

Roswell, Ind.

See the Hump

The hump in Phil Lighte's indicator diagrams, shown in the Mar. 5 issue, was undoubtedly caused by lost motion in the indicator piston or spring. If he had examined it closely he would probably have found some part not screwed up tight.

The pressure of the steam during expansion is balanced by the pressure of the indicator spring under compression. As soon as the atmospheric line is passed this changes, the pressure of the atmosphere on top of the piston becomes greater than the steam pressure in the cylinder, and the difference in pressure is balanced by the spring now placed under tension.

At this point any lost motion is bound to show itself and in this case it did on both diagrams, illustrating what a little lost motion in an indicator will do.

JOHN BAILEY.

Milwaukee, Wis.

Fuel Economy and CO_2 Recorders

The exceptions taken by Charles M. Rogers in the issue of Feb. 20, to my objections to the intermittent type of carbon-dioxide recorder in the issue of Jan. 23 are interesting, but Mr. Rogers has failed to give any reason why an intelligent fireman equipped with a dollar watch cannot conduct the few simple experiments necessary to establish the time elements of the interval during which gas is not being drawn into the apparatus.

The visibility of a single moving part of the recorder, even if it is only the chart and pen, establishes a base from which it is readily possible to work back through the entire sequence of operations and establish their time elements upon a basis which will enable the fireman operating any one or more of the boilers or furnaces connected with the apparatus to dodge the record. A variable time interval might increase the difficulty of establishing the time elements of the operations, but it would not make it impossible. Taking the samples in rotation from a number of furnaces increases the time interval between the samples from the individual furnace and gives the fireman a much better opportunity to obtain high record.

The possibility of dodging the record of the intermittent type of apparatus depends, not upon the shortness of the interval during which gas is not being taken into the apparatus, nor upon the variation in the length of this time, but upon the willingness of the fireman to ferret out the weak point by the expenditure of a little time, trouble and thought.

One and a half or two minutes is a very considerable length of time to pass between the end of one sample and the starting to take the next sample. Mr. Rogers can readily convince himself of the length of this interval by timing it. Pearl divers go down in 30 ft. of water, gather a load of shells and return to the surface in less than two minutes.

It makes no difference whether the gas is bubbled up through the solution or not; a fresh solution will take up the gas quicker than a nearly saturated one. Hence the time during which the gas is in contact with the solution depends upon the slowest acting solution.

The slowest solution should determine the length of time the gas is in contact with its surface or the length of time it takes to bubble the gas up through it. Any recorder which neglects the difference between fresh and partially saturated solutions will give an incorrect record.

A. D. WILLIAMS.

Cleveland, Ohio.

Why American Workers Excel

In the issue for Feb. 20 an article with the above title has a few statements which are worthy of a little consideration.

It is quite possible that the men in the Providence shop were studying geometry while the lathe was taking a cut, but they must have had a different kind of foreman to deal with than I ever had, or they would have got the book taken away; I had to do my figuring on the quiet. Nearly all of the young men who worked in the same shop with me across the water attended evening classes and were studying some subject connected with their work.

I have worked with young men over here whose only thought seemed to be knocking off time, so that they could get out on the corner with the boys.

As to cricket and football, a young man's efficiency is not likely to be impaired by taking an interest in healthy athletics. For that matter, our young men crowd to baseball games; is there any other subject talked of during the baseball season and does it do any harm?

If horse racing is as deeply rooted in the minds of young men as the article states, they must have changed considerably within the last few years; racing was a subject little talked of when I served my apprenticeship.

In view of all these deficiencies some will wonder how such companies as Harland & Wolff, Fairfield Shipbuilding Co., Palmers Shipbuilding Co., or any of the other large shops continue to do business. The men in responsible positions in those places certainly are paid more than 30 shillings (about $7.50) per week, and as far as I ever knew, there are few £5 ($24.33) a week jobs going begging, in spite of the fact that the men are smoking instead of studying algebra.

J. Y. GILLESPIE.

Westchester, N. Y.

Cost of Power in New England Mills

Concerning Franklin Van Winkle's criticism in a recent issue of drawing comparisons between the cost of indicated horsepower and the cost of electric horsepower delivered on the switchboard, his point is, as I understand it, that the comparative cost of power should be based on the amount of power delivered to the machines. This comparison can very readily be made, as follows:

First, assume that the electric company charges $30 per kilowatt, or $22.50 per electrical horsepower per year, for current measured at the switchboard in the mill. Further assume that the machinery is driven by electric motors arranged for group drive; that is, each motor drives several machines so that the capacity of the individual motors might be 50, 100 or 150 hp. With this arrangement a portion of the shafting will naturally be eliminated below what would be required with engine-belt drive.

At full load, the efficiency of these motors would not be better than 88 per cent., so that there is a loss to begin with of 12 per cent., for which the purchaser must pay. Let the energy loss between the switchboard and the motors in the wiring be 3 per cent. and the friction loss in shafting 15 per cent. These total up 30 per cent., which is a conservative and fair figure as actually found in practice. This means that the purchaser or consumer must pay the electric company for some 43 per cent. more energy than is actually delivered to the machines.

In the case of the engine-belt drive, the friction loss in the Fitchburg Yarn Co. plant has been measured and found to be 418 hp., or 24 per cent. of the total full load. This figure was ascertained by stopping all of the machines and running only the shafting and belts on idle pulleys. Deducting this friction load, which, it may be noticed, includes losses within the engine as well as jack, from the total indicated horsepower at average full load leaves 1326 hp. as the actual amount required at the machines. Now, as the losses with the electric drive are 30 per cent., this means that in order to deliver 1326 hp. to the machines the consumer would have to pay for 1894 hp. at the switchboard, which at $22.50 per horsepower would make a yearly rental of $42,615.

As indicated, 1326 hp. at the machines means 1744 i.hp. in the case of belted drive and multiplying 1744 hp. by $16.68, the yearly cost per indicated horsepower, makes a total yearly cost for power with belted drive of $29,090, or $13,525 less than the cost for electrical power at $22.50 per horsepower delivered at the switchboard in the mill.

Furthermore, if the consumer were buying his power, his heating item would be extra, as the 58c. cost was for coal only and contained no part of the operating and fixed charges. Making such steam for heating and for special manufacturing requirements in a special plant in conjunction with buying power from outside would add fully a dollar more per horsepower, or $1744, making the ultimate gain derived by the independent plant $15,269 yearly.

There should be a further charge against the electric drive for interest and depreciation on the heavier investment required for the motors, the switchboard and the wiring installation, which would be much greater than the saving due to the omission of the head shafts and some few line shafts with the belted drive.

The best data I have along this line relate to a large New Bedford mill which has both the mechanical transmission and the electrical drive, and where it was found that for the former it took 1 i.hp. to drive 4.5 looms, while for the electric drive the same power was consumed to drive 3.4 looms. The machines to both were identical as was also the class of goods made.

H. G. BRINCKERHOFF.

Boston, Mass.

Central Station vs. Isolated Plant

I have taken much interest in the discussion of the above topic. I am one of the "terrible, heartless and unprincipled" central-station solicitors, whose hand, according to some people, is raised against every isolated-plant engineer.

While I am at all times anxious to secure any additional power business for my company, I always try to show the conditions as they exist, and as they are most likely to be when buying power from my company.

There are a great many cases where it is a waste of time and energy for the central-station solicitor to figure on replacing private plants; in others, it is just the reverse. I recently had two cases which illustrate the uselessness of trying to win over an isolated plant. In the first case the plant owner has, and is making, money. He says that he takes a pride in having one of the finest plants in the country for its size, and that, although it might cost him $50,000 more per year to produce than to buy current, he would still run his own plant.

The other case is that of a large manufacturer who has factories in several cities and has recently established a large branch factory in Minneapolis. Some time ago his central-station service was unsatisfactory, and now he brands the whole fraternity of central-station solicitors as unreliable.

He has a very good plant; in fact, his power equipment is in duplicate. There are two engines, either of which can easily carry the load. His chief engineer expresses the belief that central-station service would be more satisfactory and cheaper than their plant, but to no avail. This factory closes at 5 p.m. and keeps a night engineer on the job running an engine until 12 p.m. to light a sign requiring 2 per cent. of the rated output of one generator rather than buy service from the company. This is an instance where prejudice runs away with judgment.

Recently I replaced a plant where it would have caused me genuine regret if the engineer had lost his position. I told the owner of the factory what a wide-awake engineer I thought he had, and asked what was to be done with him, when the new power should go in. He said he realized he had a good man and expected to have him look after the electrical equipment, shafting and machines and the steam heating used in the process of manufacture and in heating the building. This engineer will have a more pleasant job, with fully as good pay, shorter hours and very little, if any, Sunday work.

This man was "on the job" all of the time. While I was making an indicator test of the engine for power taken by various sections of the factory, he was an interested spectator and understood the meaning of the diagrams. He knew the approximate power taken by friction, that taken by various machines, the revolutions per minute of the engine, shafting, etc. The only reason the central station could secure the business was that the conditions of operation are such that it can sell them power cheaper than they can produce it.

This plant and its engineer are in marked contrast with some I have known.

V. S. BALL.

Minneapolis, Minn.

Impeller Turbine Pump or Air Lift, Which?

I would like to have POWER readers discuss the relative merits of the impeller or deep-well centrifugal turbine pump and the modern air-lift for pumping water. Until a year ago we pumped by direct suction, but the water got so low that we had to adopt other means for lifting the water, so we installed one of the above systems.

The system has given good results, but there are those who think the other system would have been better. I would especially like to hear from those engineers who have abandoned one system for the other.

B. K. GOODMAN.

Reading, Mich.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Lining Up an Engine

When lining up an engine, should the line be centered from the counter bore or piston bore?

S. F. K.

Use the counter bore, particularly when lining up an old engine; the piston bore may be out of round.

Discharge Velocity

If a centrifugal pump with an 8-in. discharge delivers 1100 gal. per minute, what is the discharge velocity in feet per second?

S. M. M.

The rule for finding the velocity of the water in feet per second is: Multiply the discharge in gallons per minute by 231 and divide the product by 720 times the area of the discharge orifice in square inches. Applying the rule to your question:

$$Velocity = \frac{1100 \times 231}{720 \times 50.26} = 7 \text{ ft. per sec.}$$

Relieving the Pressure of the Exhaust

What provision should be made to relieve the back pressure on the exhaust of a condensing engine if the vacuum should fail?

C. M. H.

An automatic relief valve should be introduced in the exhaust line, with the valve so loaded that it will open when the pressure rises to a certain point.

Water and Superheated Steam

Can water exist in an atmosphere of superheated steam?

F. B. A.

Yes, just as ice can exist in the atmosphere of a hot summer day. Both the ice will melt and the water evaporate if they are given sufficient time.

Checking a Thermometer

How can the accuracy of a thermometer be checked?

J. McG.

If the point of immersion of the bulb is marked, place it up to the mark in melting ice and the point to which the mercury falls should be 32 deg. if a Fahrenheit scale or zero if a Centigrade scale. Then place it in boiling water at atmospheric pressure, up to the immersion mark. The mercury should rise to the 212 deg. mark if Fahrenheit or to 100 deg. if Centigrade.

Cement for Steam and Water Pipes

What is a good cement for steam and water pipes?

P. G.

Try a mixture of 2 lb. of paris white, 5 lb. of litharge, ¼ lb. of yellow ochre and ¼ oz. of hemp cut up small. Mix well with linseed oil to the consistency of putty and use at once. The materials can be mixed dry, and enough for immediate use can be made up with linseed oil. This cement will set under water.

Heating Surface of a Feed Water Heater

How much surface is required in a closed feed-water heater to heat 600 cu.ft. of water per hour from 40 to 204 deg. F., the temperature of the exhaust steam being 212 deg.?

J. P. K.

To find the square feet of heating surface, divide the weight of water passing through the heater per hour by the B.t.u. transmitted to the feed water per square foot of heating surface per degree difference in temperature between the steam and the water, and multiply the result by the hyperbolic logarithm of the difference between the steam temperature and the initial temperature of the water divided by the difference between the temperature of the steam and the final temperature of the water. A good average heat transmission for counterflow heaters with plain brass or copper tubes is 250 B.t.u. per square foot per hour per degree difference. Substituting figures, the rule would be expressed thus:

$$\frac{600 \times 62.5}{250} \log.e \frac{212 - 40}{212 - 200} = \frac{37{,}500}{250} \times 2.65705 = 398.56 \text{ sq.ft.}$$

of heating surface.

Burnt Spots on the Commutator

What causes burnt spots on a commutator using carbon brushes?

A. G.

The most common causes are loose leads in the commutator lugs, high mica between bars, poor connection between the brush and the stud, and improper setting of the brushes. The trouble may be due to a combination of any of the foregoing causes.

Air Required for Engines Using Natural Gas

What mixture of air and gas will give the best results in a gas engine using natural gas?

W. A. B.

The relative volume of gas and air in the mixture depends upon the composition of the gas. The number of cubic feet of air can be approximated by multiplying the proportion of methane in the gas by 10, that of ethylene by 15, and that of hydrogen by 2½ and adding the results. For example, if the gas contained 90 per cent. of methane, 4 per cent. of ethylene and 1 per cent. of hydrogen, the following results will be obtained:

$$0.9 \times 10 = 9$$
$$0.04 \times 15 = 0.6$$
$$0.01 \times 2.5 = 0.025$$

and their sum, 9.625, will be the cubic feet of air required ordinarily per cubic foot of gas.

Synchronizing Lamps

When synchronizing with lamps, is it better to have the lamps bright or dark when the machine is in synchronism?

M. H. J.

It is safer to synchronize with the lamps bright, because a broken filament will not mislead one into throwing the machines together at the wrong time.

Synchronizing Generators

Which is preferable, synchronizing with lamps or by means of a synchroscope?

J. H. M.

The synchroscope or any synchronism indicator is preferable.

Choke Coil between a Rotary Converter and a Transformer

Can a choke coil be used between a rotary converter and its transformers so as to protect the machine in case it is thrown in when not in absolute synchronism?

W. K.

Such a precaution could be used and might be advantageous, but there should not be any necessity for it with modern apparatus for synchronizing.

New York State to Develop and Distribute Its Power

By a vote of 27 to 22, the Bayne water-power measure was passed by the New York Senate on Mar. 27. The Bayne bill provides that the state itself shall develop all water powers, generate electric power and transmit and sell it to the municipalities and factories of New York State.

The State Conservation Commissioners prepared the measure about two months ago, and it was necessary, in order to pass it before the closing of the session, to advance it out of its order and under suspension of the rules.

The Bayne bill met with considerable opposition, during which Senator Ferris offered a substitute bill. It was claimed by the opponents of the first-named bill that if the state develop its water powers and the electricity were distributed through private corporations, a large revenue would accrue to the state. Under the Bayne measure, declared Senator Ferris, the state-controlled water powers would develop only 220,000 hp.; that the state would be compelled to buy private water powers and establish steam plants to be able to furnish 1,500,000 hp., which is the amount used in the state.

Senator Bayne's explanation of the provisions of his bill is that it proposes to give the people the sole benefit from the development of the water powers of the state and the consequent generation of electricity instead of turning the state's resources over to private corporations. Under this bill the state will develop and distribute electric power made possible by the construction of water-storage dams directly to municipalities and factories without permitting private corporations to act as middlemen.

Allis-Chalmers Co. Reorganized

A new corporation will be formed of the Allis-Chalmers Co., according to the new reorganization plan, with a capital stock of $42,500,000; the stock will consist of $26,000,000 common and $16,500,000 seven per cent. accumulative preferred.

The present security holders will receive new stock in exchange on the following basis: for each $1000 five per cent. bond a total value of $1375, of which $1000 new preferred, $350 new common and $25 coupon Jan. 1 in cash; for each $100 par preferred stock upon payment of $20 in cash a total value of $110, of which $20 will be new preferred and $90 new common; for each $100 par value of common stock, a total value of $45, of which $10 will be in new preferred stock for $10 assessment and $35 in new common stock.

A voting trust of new preferred and common stock is to be created for five years with five voting trustees, to be appointed by the following reorganization committee: James M. Wallace, chairman; C. W. Cox, A. J. Hemphill, R. W. Leigh, J. H. McClement, W. E. Roosevelt and F. Vogel, Jr. It is planned also to obtain a friendly receiver, but he has not been named up to the time of going to press.

A "Carnival" of Boiler Explosions

The alarming frequency of boiler explosions is evidenced in the following press reports between Mar. 23 and 26:

On Mar. 23, five men were scalded and the boiler house at the Turner Coal Co.'s mine, near Evans City, Penn., was destroyed when one of the boilers exploded. The men were employees and were about to enter when the explosion took place. An investigation is under way, but the cause has not yet been determined.

A boiler used on the Melarky farm, near Marwood, Penn., owned by Denny & Cypher, contractors, on Mar. 25, exploded under a full head of steam. The crown-sheet was blown out, the grate bars were thrown in every direction and the fire was scattered over the belt house. No one was hurt and the rig and belt house escaped destruction.

On the same day, at Holcomb, Ala., five men were killed and three were seriously injured by the bursting of a boiler in the sawmill of Stewart & Hardin. The boiler room was completely wrecked.

The boiler of an engine running a circular saw on the H. H. Peterson farm, near Whiting, Iowa, exploded on Mar. 26, killing one man and injuring four others.

Six men were killed in the foregoing accidents and 12 men were injured. Elsewhere in this issue are recorded far more serious accidents and casualties, in which a locomotive boiler explosion at San Antonio, Tex., on Mar. 18, caused the death of 28 employees and injured over 40 others; at Salisbury, Md., 6 men were killed and 3 injured on Mar. 26; at Greentown, Penn., 4 were killed and 1 injured.

OBITUARY

It is with the deepest regret that we announce the death of Louis L. Rice, manager of *The National Engineer*. Mr. Rice was born in 1867 near Oxford, Chester County, Penn., where he received his primary education. From there he went to Philadelphia and finished his schooling and engaged in the printing business for some time, until in 1897 he started under the auspices of the American Order, the *Practical Engineer*. Mr. Rice continued to operate this publication until 1908, when, on account of ill health, he sold it to its present owners. After a couple of years of rest, Mr. Rice identified himself with *The National Engineer* as its general manager and continued in such position until his death, Mar. 18, 1912. Mr. Rice leaves a widow and three daughters to mourn his loss, and the many testimonials of esteem from those who knew him in a business way, are the strongest evidences of high character and integrity.

SOCIETY NOTES

The J. C. Jurgensen Branch of the Institute of Operating Engineers held its regular monthly meeting on Thursday, Mar. 28, at the institute headquarters, in the Engineering Societies Building, West Thirty-ninth St., New York. Over 75 members and friends were present. A. R. Maujer, member of the institute, gave a talk entitled "Ways and Means; How to Make Boiler-testing Apparatus and How to Use It." He showed how by the use of a little ingenuity and the expenditure of a small amount of effort and money an equipment for making reasonably accurate proximate coal analyses can be secured; that the heat value may be estimated from the proximate analysis in several simple ways and how the amount of air theoretically required by the coal may be ascertained. He also showed the principle upon which flue-gas apparatus is constructed, how it is manipulated and how the efficiency of combustion is calculated.

PERSONAL

Charles M. Rogers, formerly combustion engineer for the Detroit United Railway, Detroit, Mich., has accepted the position of superintendent of generation for the Empire District Electric Co., of Joplin, Mo.

Frank D. Chase, an associate member of the American Society of Civil Engineers, and architect of the Western Electric Co., has opened offices in the People's Gas Building, Chicago, for the practice of architecture and industrial engineering, making a specialty of manufacturing plants and mercantile buildings.

Dr. Rudolf Diesel, inventor of the engine bearing his name, is visiting New York and other cities in the United States. The purpose of Dr. Diesel's trip is to investigate the progress being made here with oil fuel. He may address several of the scientific bodies while here. The doctor says that America, as the land of oil *par excellence*, is destined to lead the world in the development of oil-fed motive power.

Moments with the Ad. Editor

There was some "good stuff" in an article on "Honesty in Advertising," in the New York "Globe" the other evening. It was written by Bert M. Moses, President of the Association of American Advertisers, and was so interesting that we are going to reprint it here:

"So far as can be learned from History, the wail of the world has ever been for honest men.

"With honest men in control, every problem that has confronted civilization from the Beginning to the Now would be solved.

"There would be no poverty, no crime, no wars, no epidemics, no race or religious hatreds, no discordant note anywhere.

"No one has ever undertaken to count the laws that have been passed to make honesty compulsory.

"These statistics, however, are available: In the year 1910 alone there were passed by the Federal and State Legislatures over 44,000 new laws.

"A law is something whose purpose is to compel people to do or not to do certain things.

"A law, if just, aims to make men do that which they would do without law if they were honest.

"So it seems that a great majority of the enactments passed have as their object the promotion of honesty.

"What has been the result of all these hundreds of thousands of laws?

"Is honesty any more of a glut on the market than it ever was?

"The trouble has been this:

"The law never changed human nature. It never made anybody permanently honest.

"Mankind cannot be legislated into goodness. Morality does not find its source in a Legislature, but must leap straight from the heart.

"Just now there is a nation-wide movement to make advertising honest.

"Every decent man in America is supporting that movement, and all over the land advertising clubs and associations are lifting up their voices in favor of it.

"Perhaps a majority believes the remedy lies in the law

"Others feel that there is a better way, and an only way, that ever banished any evil. That way is the Power of Public Opinion.

"Ten years ago dishonest, deceiving and false advertising was at its zenith.

"Exaggeration, falsehood, and plain lying were universal.

"The fakir and swindler were not the only offenders, but practically every advertiser indulged in extravagant and unwarranted forms of speech in promoting his wares.

"Then the real work of reform started.

"Publishers began to refuse that particular form of advertising which was fraudulent on its face.

"More and more closely was the copy scanned as time passed, until to day the professional swindler finds his way so almost completely barred that his vocation of collecting coin by fraudulent advertising is about gone.

"There still remains that semi-respectable form of advertising that deals largely in superlatives and exaggeration. But progress upward has been rapid, and it has come about, not because of law, but because men are learning without enactment that honesty is a paying proposition.

"They are learning that truthful advertising, which the public believes, 'pulls' better than misleading advertising that the public suspects.

"Public opinion is a power above and beyond laws, and, so far as I can learn, no law ever made public opinion.

"Laws are for lawyers.

"Once get advertising into their hands, and the issue will be so clouded that no man will know what he may or may not say in public print.

"Truth is a point of view, and in all History no man has yet appeared who was wise enough to say, 'This is surely so, or that is surely not so,' in the matter of merchandise.

"Public Opinion is at work, and its influence is widening and broadening daily.

"To now rush in and try to accomplish by law that which is being accomplished without law would be a blunder.

"That is the way the thing looks to me."

Doesn't this help to show why it pays to read the advertisements in your paper, and to buy advertised goods?

NEW EQUIPMENT

ATLANTIC COAST STATES

J. F. Fitzgerald, mayor of Boston, Mass., has recommended an appropriation of $28,000 for the installation of a new power plant at the Suffolk School for Boys on Rainsford Island.

The General Electric Co., Schenectady, N. Y., contemplates the expenditure of $100,000, on the construction of an experimental laboratory.

The Scalp Level Coal Co. will install electrical equipment in its establishment at Scalp Level, Penn.

E. M. Balsinger, 345 Fourth Ave., Pittsburg, Penn., is preparing plans for the construction of a power house and car barns for the Kittanning & Leechburg Rys. Co., Kittanning, Penn. William H. Stamm is chief engineer.

The Slate Belt Electric Street Ry. Co., Pen Argyl, Penn., contemplates the installation of additional equipment in its power plant. L. H. Mountney is general manager.

Meadville, Penn., is considering the installation of an electric-light plant. Harley D. Carpenter is interested.

Colonial Beach, Va., has voted bonds for $17,000 for the construction of a water-works system.

Neff & Thompson have prepared plans for the construction of a power plant to be erected at 12th St., Richmond, Va., by the Virginia Ry. & Power Co.

SOUTHERN STATES

Plans are being prepared by J. B. McCrary & Co., Atlanta, Ga., for the construction of an electric-light plant at Chipley, Ga.

J. B. McCrary & Co., Atlanta, Ga., are preparing plans for the installation of an electric-light plant at Ocilla, Ga.

Vidalia, Ga., contemplates improvements and etxensions to the municipal electric-light plant. J. W. Jordan is superintendent of the plant.

A franchise has been granted to the Tidewater Power Co., to construct and operate an electric-light plant at Birmingham, Ala. A. B. Skelding, Wilmington, N. C., is manager.

J. W. Adams, of Chattanooga, Tenn., is organizing the Union Development Co. for the purpose of building a water power plant, near Bryson City, N. C., to generate 40,000 hp. Estimated cost, $250,000.

Durham, N. C., will install a water-works system to include a 4,000,000-gal. pumping plant and a 6,000,000-gal. filter plant.

The Meriden Light & Ry. Co., Meriden, Miss., contemplates the installation of a 3000-hp. turbine in its power plant. A. B. Paterson is general manager.

Bids will be received by the public service commission of Yazoo City, Miss., until 3 p.m., Apr. 27, for furnishing steam turbine-driven alternating-current units, exciter units, railway converters, motor generator sets, switchboard panels, condensers and other accessory apparatus.

A power plant will be installed in the new Masonic building to be erected at Memphis, Tenn.

The United Water, Light & Traction Co., Somerset, Ky., will build a filtration plant. The control of the company has recently passed into the hands of the Insull interests, of Chicago, Ill. J. L. Waddle, Somerset, is general manager.

The Kentucky Public Service Co., Louisville, Ky., is now buying equipment for improvement of the plant of the Bowling Green Gas & Electric Co., which it recently acquired.

The Wisconsin Steel Co., which is building a coke-oven plant in Harlan County, Ky., is constructing the industrial town of Benham, Ky. The company will build an electric-light plant and water-works system.

Henderson, Ky., is considering enlarging the capacity of its electric-light plant in order to enable it to furnish current to the Henderson Traction Co. L. P. Hite is superintendent of plant.

CENTRAL STATES

Akron, Ohio, will install a municipal filtration plant and water-works system.

A franchise has been granted to the D. C. Shank Co., to construct an electric-light plant at Pandora, Ohio.

Bonds for $60,000 have been voted for the installation of a water-works system at Grand Haven, Mich.

Manito, Ill., is considering the installation of an electric-light plant.

Milltown, Wis., is considering the installation of a water-works system. Estimated cost, $4500.

The Hillsboro Light & Power Co., Hillsboro, Wis., has been incorporated, to erect and operate an electric-light and power plant. F. A. Wopat is president.

The Oakfield Light & Power Co., Oakfield, Wis., has been incorporated, to build and maintain an electric-light and power plant. W. E. Bristol, F. J. Carpenter and A. J. Worthing are the incorporators.

The J. I. Case Threshing Machine Co., Racine, Wis., proposes to expend $75,000 in constructing and equipping a new central power plant, on Ontario St.

The citizens of Two Rivers, Wis., plan to rebuild and enlarge the municipal electric-light plant.

WEST OF THE MISSISSIPPI

The power plant of the Hart-Parr Co., at Charles City, Iowa, was destroyed by fire recently with a loss of $10,000.

M. L. Logan will construct an electric-light plant at Sheldon, Iowa.

M. B. Lord contemplates the installation of an electric-light plant at Morris, Minn.

The establishment of an electric-light plant at Warren, Minn., is contemplated.

The Leavenworth Light, Heat & Power Co., Leavenworth, Kan., contemplates contemplates considerable improvements to its plant. W. H. Fellows is manager.

The Pawnee Rock Electric Light, Power & Ice Co. will construct an electric-light and ice plant at Pawnee Rock, Kan. F. C. Woodbury is interested.

The Blue River Power Co. contemplates the construction of a power plant in Seward, Neb. E. J. Ashton, Lincoln, Neb., is manager.

Bonds for $15,000 have been voted for the installation of a water-works system at Bowdle, S. D.

The citizens of Farmer, S. D., contemplate the installation of a street-lighting system.

Emil Benson is interested in the installation of an electric-light plant at Garretson, S. D.,

I. R. Packard, Fort Smith, Ark., will install a water-works system, at Benton, Ark.

Bonds for $65,000 have been voted by the citizens of Nacogdoches, Tex., for the installation of an electric-light plant.

The Crockett Ice, Electric Light & Power Co., Crockett, Tex., will expend about $10,000 for improvements on its plant. H. H. Powers is superintendent.

Plans are being prepared for the installation of a water-works filtration plant at Dallas, Tex. Estimated cost, $152,000.

The city council, Huntsville, Tex., has decided to install an electric pump at the Sam Houston Normal Institute.

The Temple Ice & Cold Storage Co., Temple, Tex., is enlarging the capacity of its plant.

Bonds for $55,000 have been voted for the installation of a water-works system at Alva, Okla.

Aguilar, Colo., will construct a water-works system, to cost $70,000. C. D. Livingston is interested.

D. A. Layne and W. D. Murray, of Silver City, N. M., will install an electric-light plant and ice factory, at Lordsbury, N. M.

The residents of Leland, Utah, have organized a company for the purpose of constructing an electric-light and power plant. B. Isaacs is president.

The Casa Grande Ice & Cold Storage Co., Casa Grande, Ariz., will erect an ice plant and a plant for generating electricity for light and power. Fred Humphrey is head of the company.

J. F. Kenoyer is contemplating the establishment of a street-lighting system at Albion, Wash.

Bids will be received by the Bureau of Yards and Docks, Navy Dept., Washington, D. C., until 11 a.m., Apr. 27, for two 100-kw. motor generator sets and controlling panels for the navy yard at Puget Sound, Wash.

Gladstone, Ore., is considering the installation of a water-works system, to cost $20,000. H. E. Cross is mayor.

The Smith-Powers Co. will construct an electric power plant at the Smith Mill in Marshfield, Ore.

Alameda, Calif., contemplates increasing the capacity of the municipal lighting plant at a cost of $150,000. J. B. Kahn is superintendent of plant.

The Western States Gas & Electric Co., San Francisco, Calif., contemplates the expenditure of $100,000, on improvements to its plant and system at Placerville, Calif.

Sacramento, Calif., contemplates the expenditure of $85,000 on improvements to the water-works plant. George N. Randle is city engineer.

Red Bluff, Calif., contemplates the installation of a water-works system.

Raton, N. M., is considering the construction of a new water-works system. Estimated cost, $400,000.

The installation of a new pumping plant at San Francisco, Calif., is contemplated. Marsden Manson is city engineer.

M. I. Diggs, state architect, has prepared plans for a power plant to be installed in the new armory at San Francisco, Calif. Estimated cost, $45,000.

Niagara Falls, Ont., is considering the construction of an entirely new waterworks plant.

We are informed by Benson & Bray, manufacturers of doors, sash and moldings, Midland, Ont., that this company will make improvements to its plant, costing $46,000. A new boiler room and shavings vault will be built. A large Wheelock engine, 20x46 ft., 300 hp., has been purchased. A new dry kiln, 20x52 ft., of frame construction, covered with iron will be erected.

Engineers Wanted

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

WANT a superintendent for small natural and producer-gas plant in South Dakota making light and power and pumping water; must be sober, industrious and competent to run plant described; tell what you can do in this line and mention salary you will take. Box 627, Power.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

ONE GOOD sales engineer to handle boiler-plant equipment in each of the following towns: Boston, Philadelphia, Cleveland. Address Box 626, Power.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AGENTS for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

AGENTS WANTED to sell forced draft blowers and damper regulators; will give exclusive territory to right parties; commission on sales. Turbo-Blower Co., 30 Church St., New York.

WANTED—Thoroughly competent experienced mechanical rubber salesman for the city of Chicago; must have an acquaintance among the large buying trade; state age and experience; also give references. Address Box 814, Trenton, N. J.

AGENTS selling to steam plants can make big money selling for us; no samples; no experience is necessary. Armstrong Mfg. Co., Springfield, Ohio.

AGENTS WANTED—We want a live wire agent, either engineer or specialty salesman, in every town to furnish lists of names and take orders for Akron metal gaskets, the most complete line of metal gaskets made. Write for our proposition. Akron Metallic Gasket Co., Dept. P, Akron, Ohio.

A YOUNG MECHANICAL engineer familiar with the operation of power plants, able to carry out tests of boilers, gas producers, gas engines and be familiar with all kinds of measuring instruments; applicant must give full information concerning his training and experience. Box 615, Power.

MANUFACTURERS' AGENTS to handle thoroughly guaranteed steam specialties; feed water heaters, steam and oil separators, traps and exhaust pipe heads; not necessary to represent entire line if interested in only part of it; our specialties are well advertised and of good reputation. Box 569, Power.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

CAPABLE YOUNG MAN, 20 years, familiar with high speed engines, generators, pumps, horizontal return tubular boilers auxiliary machinery, hydraulic elevators, wants day-time position in uptodate power plant in New York City. Box 625, Power.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

PATENTS SECURED—C. L. Parker, Patents, 904 G St., Washington, D. C.

WANTED—45 or 50 horsepower automatic engine, second hand. Address Star Steam Laundry, Knoxville, Tenn.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. M. Y. C., 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About five words make a line.

FIVE CORLISS vertical water leg, and sixteen Manning vertical type boilers. J. & P. Coats, Ltd., Pawtucket, R. I.

LATEST MODEL heavy duty 18x42 Brown engine, installed 1904; for sale account of removal. Box 575 Power.

BARGAINS in second hand steam engines; 10x10 low pressure vertical New York Blower Co., 7x10x15 Atlas, 11½x16 throttling balanced valve, 10x12 Allfree, 12x12 Ideal, 15x14 Ideal, 18x42 Brown Corliss, 10x20 Buckeye, 12x24 Buckeye, 10x7½x20 Buckeye. Power Equipment Co., Minneapolis, Minn.

Atherton Machine Company's plant, manufacturing a line of special silk and textile machinery, also a miscellaneous local business; well equipped machine, blacksmith, pattern and wood turning shops and iron foundry; heirs wish to sell; an exceptional opportunity for a live man. Box 624, Power.

ONE 120 kilowatt, a.c., 440 volts, Westinghouse generator, belted to 16x42 Allis Corliss engine, complete with exciter, switchboard and all fittings. One 20 kilowatt, d.c., 230 volt, C. & C. Electric Co. generator, direct connected to 8x10 Allfree engine. All of the above in fine shape. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

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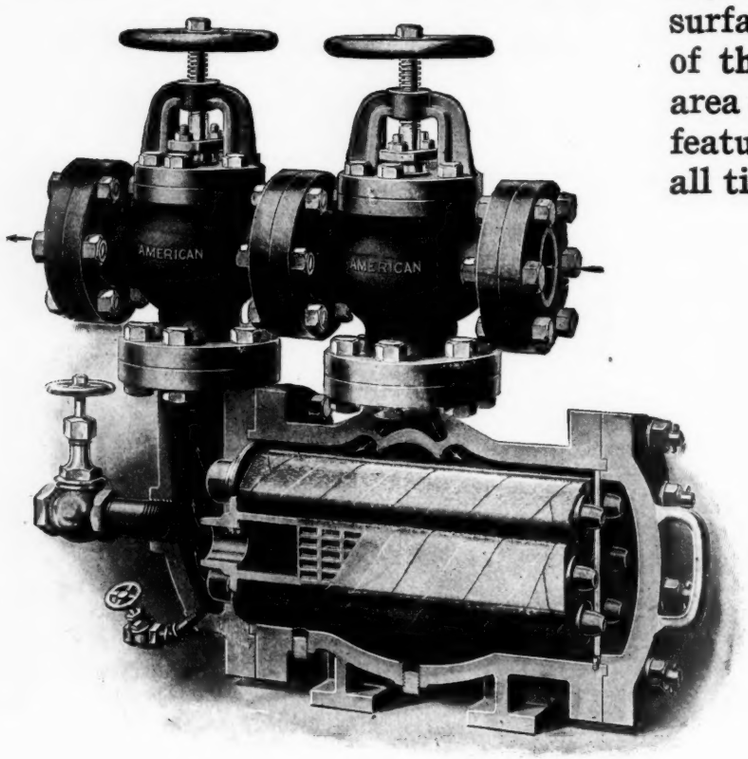
Protect Your Plant From Serious Trouble

Oil or grease are trouble makers. They breed serious trouble if allowed to get into the boiler and if you are awake to a full realization of your duty you will take steps at once to keep oil and grease from getting into the boilers.

The "how to do it" is answered by the American H_2O Grease Extracting Feed Water Filter, a device which guarantees positive insurance from bagging plates—and worse.

If oil or grease are getting to your boiler, no matter under what pressure it is working, there is likely to be trouble—and you may go up in the air with the plant. Take steps to protect your plant NOW.

The American H_2O Grease Extracting Feed Water Filter has a filtering surface equal to 320 times the area of the feed water pipes—a greater area than ever before obtained. This feature assures positive filtration at all times and under all conditions.



Write For Pocket Edition Catalog

We will send you a copy of this handy book for your own use. The coupon starts it in your direction *at once.*

The Pocket Edition of the American Catalog is worth sending for immediately. We'll expect to hear from you.

SIGN AND MAIL COUPON

American Steam Gauge & Valve Mfg. Co.
Boston, Mass. 4-9-12

Send me your Pocket Edition catalog

Name. . . . . .

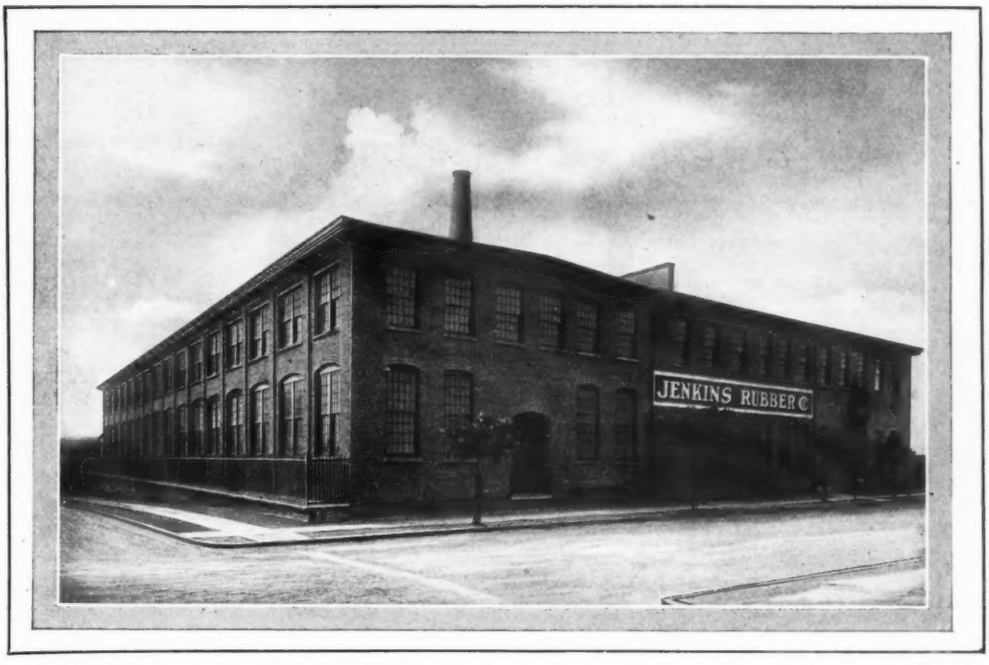
Address. . . . . .

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Sales Offices in New York, Chicago, San Francisco, Pittsburg, Atlanta, Montreal

THE BEST HOUSES EVERYWHERE SELL OUR PRODUCTS

No Steam Wasted If You Use JENKINS BROS. RUBBER GOODS



THIS is the factory where Jenkins Bros. Rubber Goods are made for your satisfaction. The same high standard that has given Jenkins Bros. Valves their reputation also distinguishes Jenkins Bros. rubber goods.

Jenkins '96 Packing has the important qualities of flexibility, strength and durability. It is the ideal unvulcanized rubber sheeting for the packing of all kinds of steam joints.

Jenkins Discs are widely known on account of their extensive use in the Jenkins Bros. Valves. They are made in various compounds, each best suited for a particular kind of service.

Jenkins Bros. Pump Valves, Gaskets, Gasket Tubing and other goods are all very carefully manufactured with the desire on the part of the makers to produce only the best.

Ask your dealer. He will be glad to supply you.
Our 1912 Catalog sent on request.

Jenkins Bros.

80 White Street, New York **35 High Street, Boston** **300 West Lake Street, Chicago** **133 N. 7th Street, Philadelphia**

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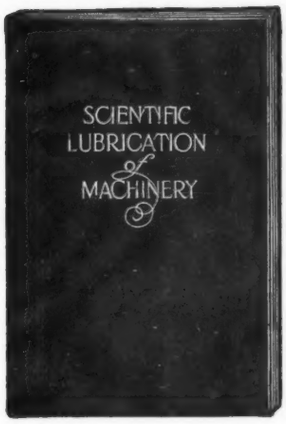

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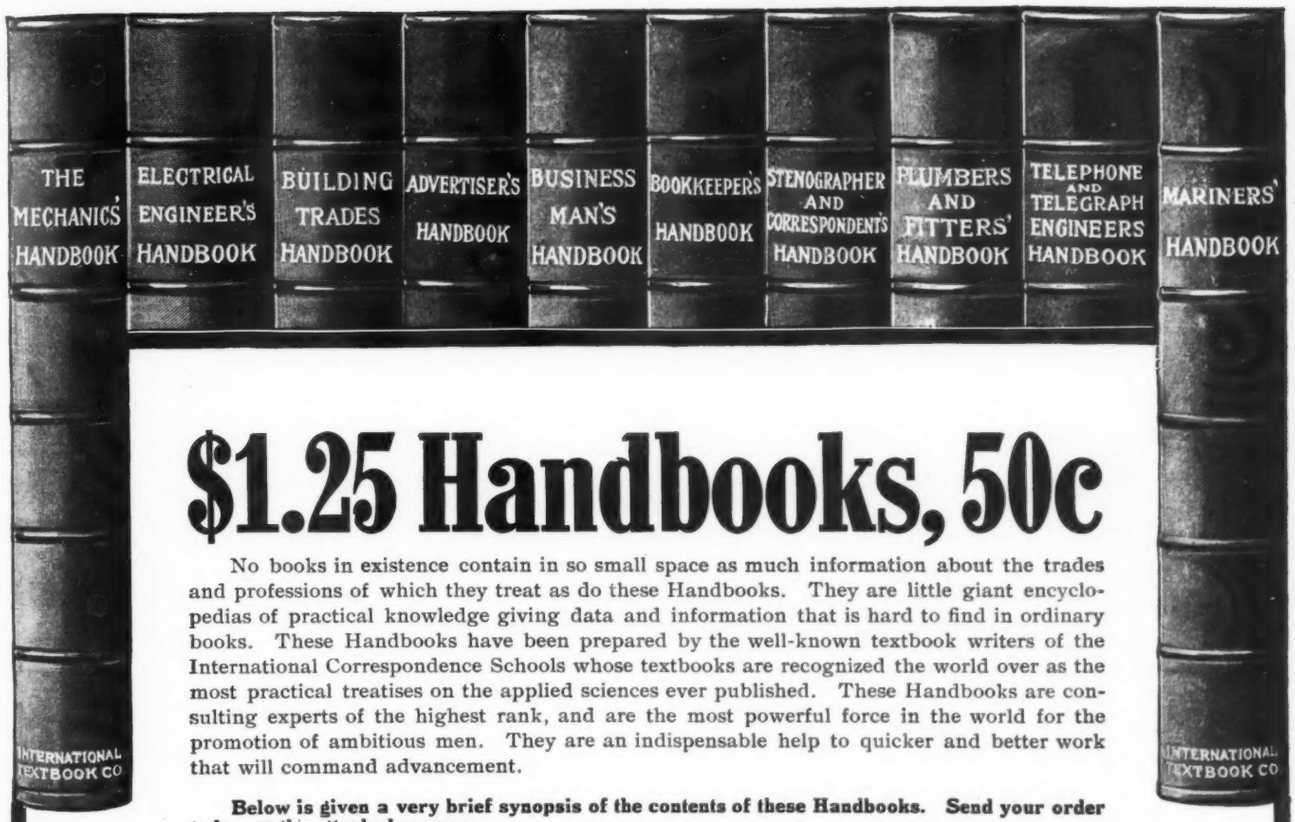

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A 750-kw. turbine plant supplying electrical energy to underground motor-driven pumping station. C. A. Tupper.

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The influence of various fixed charges upon the rates and the effect of load factor upon total cost.

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CONDENSER HEAD BROKEN BY THE GASKET:

Due to lack of packing an inside joint was made and vibration caused by pump cracked head. W. G. Freer.

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THE KIENAST STEAM TURBINE:

A turbine of German design employing concentric blading by which the steam is made to act upon the same wheel several times.

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BALANCED DRAFT FURNACE REGULATION:

The rate of admitting air to the furnace and the escape of gases to the atmosphere are automatically controlled. Warren O. Rogers.

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EXPLODING TANK WRECKS BUILDING:

Acid eats away metal at joint and weakens the tank to the point of failure.

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COTTON VERSUS MANILA ROPE:

Cotton-rope drives are not appreciated in this country, due perhaps to an inferior quality of rope. Henry D. Jackson.

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AN ENGINE ROOM EXPERIENCE:

To cut down expenses the engineer was discharged and the fireman given charge of the plant with disastrous results. Alonzo G. Collins.

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THE OIL POWER YACHT "MAIRI":

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Corrcsion of stays causes explosion of single riveted lap-seam boiler, killing four and injuring a fifth man. Carl H. Beach.

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SAN ANTCNIO LOCOMOTIVE BOILER EXPLOSION:

A result of overpressure permitted by a safety valve which had been previously screwed down. Twenty-eight were killed and forty injured.

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BOILER EXPLOSION AT SALISBURY, MD.:

A second-hand lap-seam boiler with cogwheel wired to lever of safety valve suddenly "let go," killing six and injuring three. F. A. Grier, Jr.

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EXPLOSICN OF A BEAM ENGINE FLYWHEEL:

Flywheel was made up of eight segments and belonged to an old beam engine making 40 r.p.m. John S. Leese.

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